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Engineering Evaluation/Cost Analysis
Kerr-McGee Residential Areas Site and Portions of the Kress Creek Site
In and Near West Chicago, Illinois

WA 71-5LQV/Contract No. 68-W8-0040
August 1994

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Acronyms

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ANL	Argonne National Laboratory
ARARs	applicable or relevant and appropriate requirements
ARMS	Aerial Radiological Monitoring Survey
bls	below land surface
BNI	Bechtel National, Inc.
CAA	Clean Air Act
CEDE	committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
cpm	counts per minute
CRP	Community Relations Plan
CWA	Clean Water Act
DOE	Department of Energy
DOT	Department of Transportation
dpm	disintegrations per minute
DWR	Department of Water Resources
EDE	effective dose equivalent
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
EPTOX	Extraction Procedure Toxicity Characteristic
FEMA	Federal Emergency and Management Association
H_2SO_4	sulfuric acid
HCl	hydrochloric acid
HEAST	Health Effects Assessment Summary Table
HF	hydrofluoric acid
HNO_3	nitric acid
HSL	Hazardous Substances List
HSP	Health and Safety Plan
ICRP	International Commission on Radiation Protection
IDNS	Illinois Department of Nuclear Safety
IDOT	Illinois Department of Transportation
IDW	investigation-derived waste
LLW	low-level waste
LSA	low specific activity
mph	miles per hour
NaOH	sodium hydroxide
NCP	National Contingency Plan
NESHAPS	National Emission Standards for Hazardous Air Pollutants

Acronyms
(continued)

NFA	no further action
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
ppb	parts per billion
OSWER	Office of Solid Waste and Emergency Response
PPE	Personal Protective Equipment
PRG	preliminary removal goal
PRP	potentially responsible party
PRSC	post-removal site control
PSF	Physical Separation Facility
QA	quality assurance
QC	quality control
RA	Remedial Action
RAO	removal action objectives
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SACM	Superfund Accelerated Cleanup Model
SARA	Superfund Amendments and Reauthorization Act
SC&A	Sanford Cohen & Associates, Inc.
SRE	Streamlined Risk Evaluation
SSC	Site Safety Coordinator
TBC	to-be-considered
TCLP	Toxicity Characteristic Leaching Procedure
TEDE	total effective dose equivalent
UBK	Uptake Biokinetic
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WL	working level

Executive Summary

This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared by the U.S. Environmental Protection Agency (EPA) in accordance with 40 Code of Federal Regulations (CFR) Part 300.415 (Removal Action) of the National Contingency Plan (NCP). This EE/CA addresses the proposed expedited removal of contaminated soils from the Kerr-McGee Residential Areas site and portions of the Kress Creek site located in and around West Chicago, Illinois. The EE/CA identifies the objectives and goals of the removal action, analyzes and compares various alternatives that may be used to satisfy those objectives and goals, documents the selection of the preferred alternative, and provides a vehicle for public involvement in the selection process. Removal implementation will begin only after the EE/CA has undergone public comment and an Action Memorandum has been issued by EPA. The Action Memorandum is a primary summary and decision document that substantiates the need for a removal action, identifies the proposed action, and explains the rationale for the removal action selection.

The Residential Areas site and the Kress Creek/West Branch of the DuPage River (Kress Creek) site are two of four sites in the West Chicago area listed by EPA on the National Priorities List (NPL). The contamination at these four sites originated from ore processing operations at the Kerr-McGee West Chicago Rare Earths Facility. The Residential Areas site encompasses residential and other properties in the general area around the Rare Earths Facility where thorium-contaminated mill tailings may have been windblown or transported for use as fill. The Kress Creek site passes through the Residential Areas site. Some residential properties located along the creek extend into the contaminated floodplain of the Kress Creek site. The portions of the Kress Creek site addressed in this EE/CA are those floodplains that are in residential areas.

The contamination consists of radioactive thorium, uranium, and associated decay products such as radium, radon, and thoron. Elevated metals also may be present. As a result of the radioactive decay of thorium and uranium in soil, elevated indoor concentrations of thoron and radon gas and daughter particulates may be exhibited in some houses, while others may exhibit elevated levels of indoor and/or outdoor gamma radiation.

Wherever practicable, EPA intends to address the contamination problems at the Residential Areas site and portions of the Kress Creek site by removal actions. Two key strategies for the site are as follows: (1) the removal action serves as an early action that precedes the site's Remedial Action (RA) and (2) the detailed and comprehensive site investigation will be performed concurrently with removal implementation. The direct result of these two strategies is prompt risk reduction. Because the detailed site investigation is yet to be performed, complete property-specific information is unavailable for the EE/CA; the resulting uncertainties for the EE/CA include the volume of contaminated material to be excavated and the nature of metals contamination at the site. The removal action scope does not address (1) naturally occurring soil contamination or (2) groundwater and surface water.

Past site investigation programs initiated voluntarily by Kerr-McGee in the mid 1980s included surveys of essentially all properties in West Chicago that might contain thorium residuals. Of the 2,733 properties surveyed, this program detected residuals at 117 sites that exceeded the Kerr-McGee external gamma exposure criterion of 30 μR/hr at 1-m height. With assistance from the city, Kerr-McGee excavated almost 35,000 yd^3 of thorium residuals from 116 of the 117 identified sites within the city by the end of 1985. The thorium residuals were transported to and placed at the factory site for storage.

Since 1988, ongoing surveillance activities of the Illinois Department of Nuclear Safety (IDNS) have identified additional properties with elevated radiation exposure levels beyond those properties identified and remediated by Kerr-McGee. EPA initiated a preliminary focused risk assessment of the site in 1991 and determined that excess lifetime carcinogenic health risks at the contaminated residential properties are of concern. Based on the preliminary focused risk assessment, the most probable exposure pathways that could result in exposure are anticipated as (1) direct gamma exposure of human receptors, (2) incidental ingestion of contaminated soil, and (3) human inhalation of radon and thoron gas emanating to indoor areas from contaminated soil.

The removal action objectives (RAOs) for the site are to minimize potential health hazards to humans living or working on contaminated properties, to minimize potential environmental impacts from the soil contamination, to be cost-effective, to utilize permanent solutions to the maximum extent practicable, and to establish soil conditions that comply with all applicable or relevant and appropriate requirements (ARARs). Specific removal goals to meet the above objectives have been established by EPA in their *Action Criteria for Superfund Removal Actions at the Kerr-McGee Residential Areas Site: West Chicago, Illinois*, released in November 1993 (see Appendix A). The goals (for verification of cleanup) specify the following:

- Radium-specific activity in soil—Dry soil concentrations of total radium must not exceed 5 pCi/g above background levels averaged over areas up to 100 m^2 in any 15-cm depth.

- Outdoor gamma exposure rates—The exposure rates must not statistically exceed background at a distance of 100 cm from the ground surface.

- Indoor gamma exposure rates—The exposure rates should not statistically exceed background. (This criterion will be used as a "finding tool" during removal implementation to determine if additional removal is necessary.)

- Indoor radon and thoron decay product concentrations—Reasonable efforts must be made to achieve an annual average concentration (including background) in occupied buildings of no more than 0.02 working level (WL); in any situation, the concentration (including background) must not exceed 0.03 WL.

- As low as reasonably achievable (ALARA)—Every reasonable effort shall be made to maintain radiation exposures and the amount of radioactive materials in unrestricted areas to levels that are as low as is reasonably achievable.

The potential metals of concern, based on soil data collected at the Kerr-McGee Rare Earths Facility and other Kerr-McGee Superfund sites, are lead, barium, and chromium. The removal action goal for lead is based on an EPA-recommended interim lead cleanup limit in soil of 400 mg/kg and is considered protective for direct contact in residential settings. Health-based removal action goals for barium and chromium, developed following standard EPA risk assessment protocols, are 11,600 mg/kg for barium and 830 mg/kg for chromium.

A series of general response actions, applicable for the removal action, were identified in support of the RAOs. These general response actions were radon and thoron reduction, institutional controls, containment, excavation and restoration, treatment, interim storage, disposal, and recontamination prevention. This last response action refers to minimizing risks of recontamination from potential floods to portions of the Kress Creek site. If the floodplains are cleaned up before the rest of the Kress Creek site is remediated, flooding could deposit contaminated sediments on the floodplains, which would then require additional cleanup if the contaminant levels exceed EPA's action criteria. As allowed under the EE/CA guidance, experience at similar sites and best professional judgment were used to screen the general response actions. After screening, the remaining response actions were assembled into the following RA alternatives:

- Alternative 1—No Action
- Alternative 2—Source Removal

Alternative 2 consisted of excavation of the contaminated soil (to meet the removal action objectives and goals), backfill of excavated areas with clean soil, restoration of the properties to the original condition, packaging and transportation of the soil to the Rare Earths Facility railspur by truck, transloading the soil onto rail cars at the Rare Earths Facility, and then shipping the soil to a licensed commercial waste management facility (e.g., Envirocare of Utah) for final disposal.

Two contingent actions were also identified for Alternative 2 in the event that difficulties occurred in staging, transporting, or disposing of the excavated soil:

- Alternative 2, Contingent Action A—Interim Storage (temporary storage of the excavated soil at the Rare Earths Facility for up to 1 year)

- Alternative 2, Contingent Action B—Off-Rare Earths Facility Staging Area (for transporting the packaged soil by truck to a railspur different from the one at the Rare Earths Facility)

A third contingent action was identified for Alternative 2 as a temporary mitigation measure for potential flooding of cleaned-up portions of the Kress Creek site:

- Alternative 2, Contingent Action C—Recontamination Prevention (installing steel sheet piling between the stream and the residential properties)

The alternatives were evaluated using the criteria of effectiveness, implementability, and cost. A comparative analysis for each evaluation criterion was performed for each alternative relative to the others (see Table ES-1). Key issues related to the contingent actions are discussed in Table ES-2.

Based on a comparison of alternatives, the preferred alternative is source removal (Alternative 2) for the Residential Areas site. Contingencies A and B would be implemented only if needed. The source removal alternative essentially eliminates the exposure pathways from the contaminated soil to the public and the environment, while reducing its potential for migration by placing it into a permanent disposal facility. This alternative is judged to be effective in the long term, while being technically feasible to implement. However, the cost to implement this alternative is high.

Source removal is also the preferred alternative for portions of the Kress Creek site because of similarities in contamination, geographical area, and the potential threat to public health. Contingent Action C, though technically feasible and potentially less expensive than a second cleanup (if needed), is not preferred because of administrative hurdles to implementation, the potential displeasure of property owners with the flood barrier, and the assumption that the probability is low for a flood with significant consequences to occur prior to the Kress Creek site remediation.

Table ES-1 Comparative Analysis of Removal Action Alternatives Residential Areas Site and Portions of the Kress Creek Site		
Criteria	**Alternative 1 – No Action**	**Alternative 2 – Source Removal**
Effectiveness	No protection provided; no immediate change in human health and environmental impacts.	Short-term impacts on human health and the environment during the removal can be mitigated.
	Exposure could potentially increase in localized areas if below-surface contamination is inadvertently disturbed.	Protective of public health and the environment over the long term for the Residential Areas site; additional (post-removal) remediation of the properties will likely not be necessary. Overall effectiveness of removal action for portions of the Kress Creek site is dependent on the probability of recontamination.
	Does not comply with ARARs.	Complies with ARARs.
	No reduction in toxicity, mobility, or volume.	No reduction in toxicity, mobility, or volume, but waste is contained at disposal facility.
Implementability	Technical feasibility not applicable.	Alternative is technically feasible since excavation, restoration, transportation, disposal, and health physics aspects use standard techniques and readily available equipment.
	Alternative is administratively infeasible given state and local concerns about perceived and actual risks, reduced property values, marketability, and potentially restricted land use.	Alternative is administratively feasible, but advance planning is critical for EPA's aggressive schedule. Time will be needed to obtain agreements with property owners, obtain permits from state and local authorities, and provide for a waste transloading facility and rail shipment. A license amendment may be needed for Kerr-McGee to receive material at the Rare Earths Facility from the Superfund sites.
	Availability of services and materials not applicable.	All services and materials needed for implementation are obtainable.
Cost	Zero cost.	Total costs are estimated as follows: - \$22 million for 15,000 yd^3 (50 properties) - \$39 million for 30,000 yd^3 (100 properties) - \$65 million for 60,000 yd^3 (200 properties) - \$119 million for 120,000 yd^3 (400 properties) Costs will increase in rough proportion to the number of properties with contamination found under structural foundations.

Table ES-2
Key Issues Analyses of Alternative 2 Contingent Actions

Criteria	Contingent Actions: A: Interim Storage	Contingent Actions: B: Off-Rare Earths Facility Staging Area	Contingent Actions: C: Recontamination Prevention
Effectiveness[a]	Action decreases exposure at the properties by not delaying removal. Incremental increases of exposure around the Rare Earths Facility do not cause the regulatory limit to be exceeded.	Action decreases exposure at the residences by not delaying removal. No incremental exposures are expected for the worker. Incremental exposures to the public at the staging area are slight.	Action provides a temporary access barrier to contaminated stream sediments and a flood barrier to prevent recontamination for cleaned-up floodplain soils. The measure disturbs wetlands and natural drainage within the floodplain.
	Complies with ARARs.	Complies with ARARs.	Complies with ARARs.
Implementability	Technically feasible.	Staging areas are available.	Installation can be performed with readily available equipment.
	A license amendment for storage is required from IDNS.	Administratively feasible.	Regulatory requirements are exacting and may delay installation. The barrier impacts aesthetics of and access to the stream.
	All services and materials needed for implementation are obtainable.	All services and materials needed for implementation are obtainable.	All services and materials needed for implementation are obtainable.
Cost[b]	3 to 4%	0.8 to 1.2%	1 to 7%[c]

[a]The contingent actions are all temporary responses, and so some of the effectiveness criteria, such as long-term protectiveness of public health and the environment, as well as reduction of toxicity, mobility, or volume through treatment, do not apply.
[b]The costs are incremental costs above the base cost of Alternative 2, shown as percentages of the base cost.
[c]The incremental cost does not include potential flood volume mitigation expenses. The incremental cost shown is less expensive by a factor of 2 to 3 than cleaning up the floodplain's soils a second time given a hypothetical situation where a significant fraction of the floodplains was recontaminated to levels above the action criteria. However, full cost effectiveness can only be demonstrated if it is assumed that the probability is high for occurrence of such a severe flood.

Section 1
Introduction

This Engineering Evaluation/Cost Analysis (EE/CA) has been prepared for the U.S. Environmental Protection Agency (EPA) under authorization of EPA Contract Number 68-WA-0040 and Work Assignment No. 71-5LQV. This EE/CA addresses the proposed expedited removal of contaminated materials from the Kerr-McGee Residential Areas site and portions of the Kress Creek site in and near West Chicago, Illinois.

1.1 General Purpose of an EE/CA

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; commonly known as Superfund), as amended by the Superfund Amendments and Reauthorization Act (SARA), authorizes EPA to take appropriate removal actions whenever a threat exists to public health or welfare or the environment from hazardous substances released into the environment. In general, a removal action may be taken to abate, prevent, minimize, stabilize, mitigate, or eliminate a release or threat of release. An EE/CA is used to evaluate removal action alternatives and is required under the National Contingency Plan (NCP) prior to conducting non-time-critical removal actions for a site [see 40 Code of Federal Regulations (CFR) 300.415]. Non-time-critical removal actions may be interim or final actions. The general purposes of an EE/CA, and the purposes of this EE/CA for the Residential Areas site and portions of the Kress Creek site, are to identify the objectives of the removal action, to analyze and compare various alternatives that may be used to satisfy these objectives, to document the proposed selection of an alternative, and to provide a vehicle for public involvement in the selection process (see Figure 1-1).

1.2 Site Eligibility for EPA Response

The Kerr-McGee Residential Areas site and the Kress Creek/West Branch of the DuPage River (Kress Creek) site are two of four sites (see Table 1-1) in West Chicago, Illinois, and adjacent DuPage County, that are contaminated with radioactive thorium (and to a lesser extent, uranium) and associated decay products. The other two sites, which are not subjects of this EE/CA, include the Sewage Treatment Plant and Reed-Keppler Park. The thorium contamination at these four sites originated from ore processing operations at the Kerr-McGee Chemical Corporation West Chicago Rare Earths Facility.

The Residential Areas site consists of the general area around the Rare Earths Facility (see Section 1.3) where thorium-contaminated mill tailings may have been windblown or transported and used as fill. As a result of the radioactive decay of thorium (and uranium) in the soil, elevated levels of outdoor and/or indoor gamma radiation may be exhibited at properties where the tailings are located. Some homes may additionally exhibit elevated

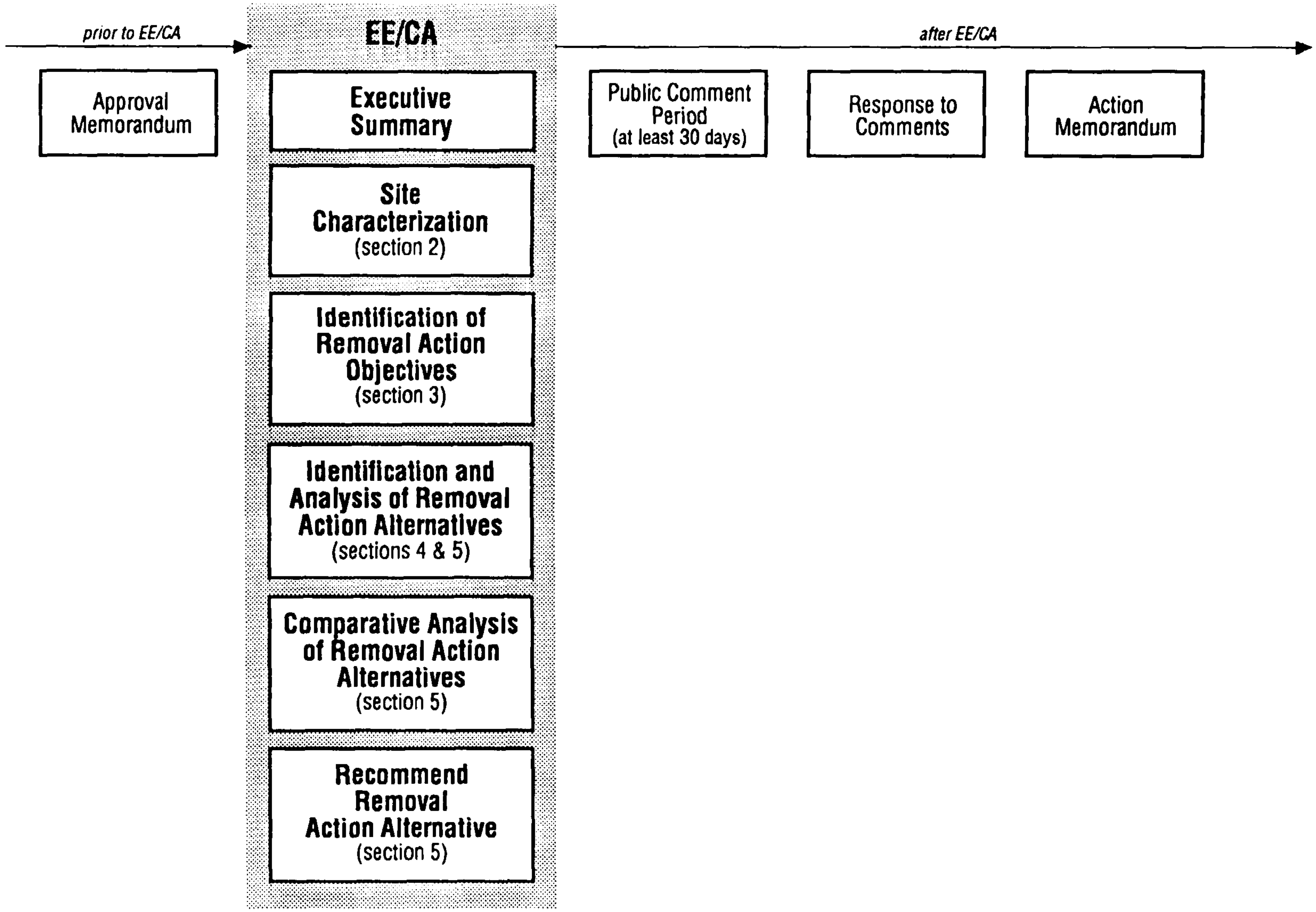


Figure 1-1
EE/CA Development Process
Residential Areas Site and Portions of the Kress Creek Site

[Extracted from Reference: EPA (1993b)]

Table 1-1
Kerr-McGee Sites in West Chicago on the NPL

Site Name	Location (see Figure 1-2)	Source of Contamination	Current Status (July 1994)
Residential Areas	General vicinity of the Rare Earths Facility	Rare Earths Facility tailings used as fill; windblown material	Removal (EE/CA)
Sewage Treatment Plant	Site is ~1 mile southeast of the Rare Earths Facility	Rare Earths Facility tailings used as fill	Remedial (RI/FS)
Reed-Keppler Park	Site is ~1 mile north of the Rare Earths Facility	Rare Earths Facility tailings used as fill	Remedial (RI/FS)
Kress Creek	Site runs south-southeast from the Rare Earths Facility	Rare Earths Facility discharges and runoff via a storm sewer	Remedial (RI/FS) and Removal (EE/CA)

Abbreviations:

NPL = National Priorities List
EE/CA = Engineering Evaluation/Cost Analysis
RI/FS = Remedial Investigation/Feasibility Study

indoor concentrations of thoron (and radon) gas and thoron (and radon) decay products. The Kress Creek site, contaminated by surface drainage from the Rare Earths Facility, consists of portions of the West Branch DuPage River and its tributary, Kress Creek, and neighboring floodplains (a floodplain is an area bordering a river or creek channel that is subject to flooding). The Kress Creek site passes through the Residential Areas site. Some residential properties located along the river or creek extend into the floodplain of the Kress Creek site. These floodplains may exhibit elevated levels of gamma radiation. The portions of the Kress Creek site addressed in this EE/CA are those floodplain areas that are residential.

Portions of the Kress Creek site are included in this EE/CA with the Residential Areas site because of similarities in contamination, geographical area, the potential threat to public health or welfare, and the potential removal actions.

The four Kerr-McGee sites are listed by EPA on the National Priorities List (NPL). The NPL is a list of hazardous waste sites that are eligible for EPA response actions under Superfund, and placement on the list indicates that site contamination may present an imminent and substantial endangerment to public health, welfare, or the environment. The four sites were placed on the "proposed" NPL by EPA in October 1984 and on the "final" NPL by February 1991. Each of the four NPL sites will be addressed by EPA in separate actions. The Rare Earths Facility is where the contamination originated, but it has not been listed on the NPL; it is regulated under the licensing authority of the Illinois Department of Nuclear Safety (IDNS). Decommissioning, cleanup, and closure of the Rare Earths Facility currently is being addressed in separate actions under that authority.

1.3 Location of Study Area

As mentioned above, the Residential Areas site encompasses all those areas in and around West Chicago, Illinois, that are potentially contaminated with thorium mill tailings from the Rare Earths Facility, but are not part of the other three Superfund sites (i.e., Sewage Treatment Plant, Reed-Keppler Park, and Kress Creek) or the Rare Earths Facility. The site includes residential properties as well as institutional properties, commercial properties, and public or community infrastructure areas such as parks, streets, curbs, parkways, and alleys, if found to be contaminated.

The removal action may also deal with the contaminated portions of residential properties above the waterline in the floodplain (not the channel sediments) of the Kress Creek site. This site is bounded by the surface stream, Kress Creek, at the Kerr-McGee Rare Earths Facility storm sewer outfall and extends to its confluence with the West Branch DuPage River (approximately 1.4 miles), then extends down the West Branch DuPage River to Illinois Route 56 (approximately 2.6 miles). The site extends laterally to 400 ft on each side, incorporating the 100-year floodplain. Kress Creek has received radiologically contaminated wastes via a storm sewer discharge from the Rare Earths Facility. The storm sewer carries surface drainage from the facility and empties directly to the creek.

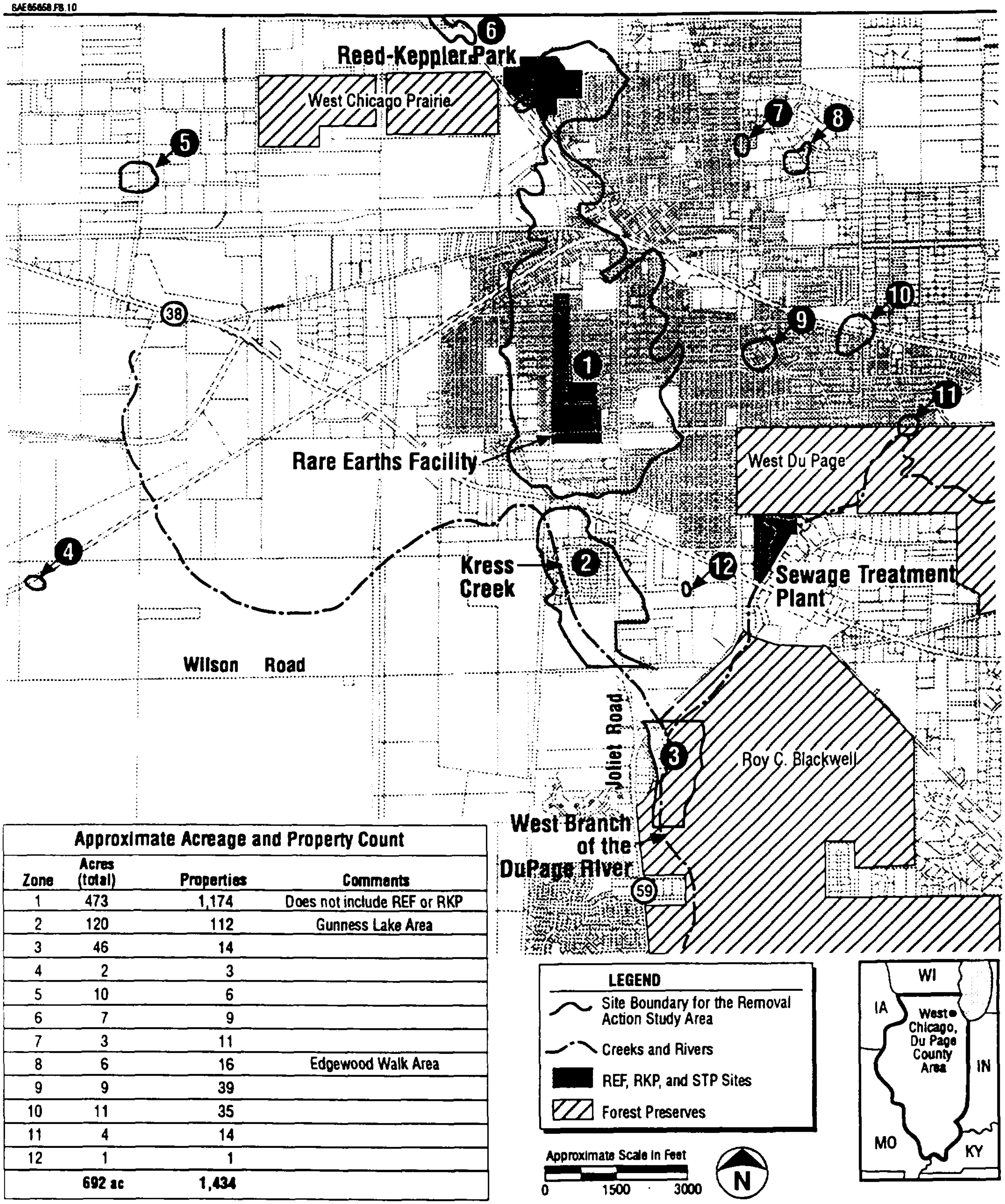
In 1989, EG&G performed an aerial radiological survey (flyover) for the IDNS in and around West Chicago, Illinois, and identified general zones of elevated gamma readings. With few exceptions, the contaminated properties are expected to be located within or near the boundaries of elevated gamma readings (i.e., flyover contours). Although the Residential Areas site and relevant portions of the Kress Creek site have not yet been characterized in detail, a major fraction of the area enclosed by the flyover contours has been designated by EPA as the practical areal extent for the removal action study area (see Figure 1-2). (Flyover contour zones not assigned to the study area have been assigned to the Sewage Treatment Plant and the Kress Creek sites—these zones are not shown in Figure 1-2.) To test whether the flyover contours enclose the contaminated properties, the site investigation for discovery and characterization (see Section 1.4) will include properties within the contours as well as those slightly outside the contours. In addition, EPA is currently considering other activities and methods to investigate the areas outside the contours for possible contamination from Rare Earths Facility thorium mill tailings. If contaminated properties are found outside of the flyover contours, the site boundaries will expand to include them. However, for purposes of discussion in this EE/CA and until characterization data indicate otherwise, the boundaries for the study area are equivalent to the boundaries of elevated gamma readings shown in Figure 1-2.

Figure 1-2 also shows the approximate acreage and number of properties associated with each of 12 noncontiguous areas of the removal action study area. The largest zone of the study area (Zone 1), corresponding to the largest area of elevated gamma readings, encompasses approximately 473 acres and contains approximately 1,174 private and public properties. These acreage and property count values do not include the Rare Earths Facility or the portion of the Reed-Keppler Park that lie within the flyover contour. The Rare Earths Facility is being addressed under authority of the IDNS, and Reed-Keppler Park is being addressed by EPA in a separate action. The second largest zone of the study area (Zone 2) is the northern half of the second largest area of elevated gamma readings where Kress Creek flows. This zone encompasses approximately 120 acres and 112 properties. The portions of the Kress Creek site addressed in this EE/CA are the residential properties along Kress Creek in Zone 2 (18 properties) and the residential properties along Kress Creek/DuPage River in Zone 3 (6 properties). [The other portions of the Kress Creek site not addressed in this EE/CA are part of a separate EPA Remedial Action (RA)]. The removal action study area, including all 12 zones, encompasses approximately 692 acres and 1,434 properties.

1.4 Regulatory Strategy

Two key strategies for the Residential Areas site and portions of the Kress Creek site are that (1) the removal action serves as an early action that precedes the sites' RA and (2) the detailed site investigation will be performed concurrently with removal implementation.

The direct consequence of these strategies is prompt risk reduction. These two strategies are further discussed below.



Approximate Acreage and Property Count

Zone	Acres (total)	Properties	Comments
1	473	1,174	Does not include REF or RKP
2	120	112	Gunness Lake Area
3	46	14	
4	2	3	
5	10	6	
6	7	9	
7	3	11	
8	6	16	Edgewood Walk Area
9	9	39	
10	11	35	
11	4	14	
12	1	1	
	692 ac	1,434	

Figure 1-2
Study Area
Residential Areas Site and Portions of the Kress Creek Site

1.4.1 Removal as an Early Action

The current system for Superfund cleanups is based on two programs—remedial and removal.

- The remedial program is traditionally geared toward long-term remedies, often addressing risks with comprehensive multi-media alternatives. These remedies are usually more expensive; thus, the evaluation of alternatives is often more elaborate.

- The removal program has traditionally been used to clean up immediate risk threats, both those requiring immediate attention (emergency and time-critical removals) and those that even with some immediate risk can afford some planning activities (non-time-critical removals).

Removal actions generally have both cost and time constraints: "Fund-financed removal actions [...] shall be terminated after $2 million has been obligated for the action or 12 months have elapsed from the date that removal activities begin on-site, unless the lead agency determines that: (i) There is an immediate risk to public health [...] or (ii) Continued response action is otherwise appropriate [...]" [40 CFR 300.415 (b)(5)]. These statutory limits are not in effect if potentially responsible parties (PRPs) do the work. Because of lower costs and more immediate or obvious risks, the site characterization and alternative evaluation phases of a removal action are also more focused. This focus can save time and money over a traditional remedial documentation approach.

Flexibility in Superfund activities is being encouraged by EPA through the new Superfund Accelerated Cleanup Model (SACM). SACM encourages early actions, such as non-time-critical removal actions, to be taken at sites. This allows focused actions that reduce risk to be taken sooner at sites that already have been characterized and for which remedial alternatives are known or limited. This concept of expedited removals to mitigate risk is being applied to the Residential Areas site and portions of the Kress Creek site in West Chicago.

Following the non-time-critical removal, a final Remedial Investigation/Feasibility Study (RI/FS) will be conducted to determine if additional action is warranted. The decision whether further remediation is warranted will be heavily based on a residual risk assessment that will be conducted on the post-removal site. Data to support the risk assessment will generally be collected prior to the RI/FS (i.e., the approach taken for the Residential Areas site and portions of the Kress Creek site will be to collect data during the removal action to support the removal action and the RI/FS, and thereby avoid another sampling event during the RI/FS).

1.4.2 Investigation and Removal as Concurrent Activities

One of the major regulatory strategies for the Residential Areas site and portions of the Kress Creek site is that a detailed site investigation will be performed concurrently with removal implementation. Figure 1-3 shows a simplified removal action timeline indicating major activities and participants for the Residential Areas site. Additional detail on some project activities such as project management, quality control (QC), data management and evaluation, and coordination among participants can be found in the Residential Areas site Work Plan (EPA, 1994). EPA is conducting an RI/FS on the entire Kress Creek site concurrent with removal actions on residential areas.

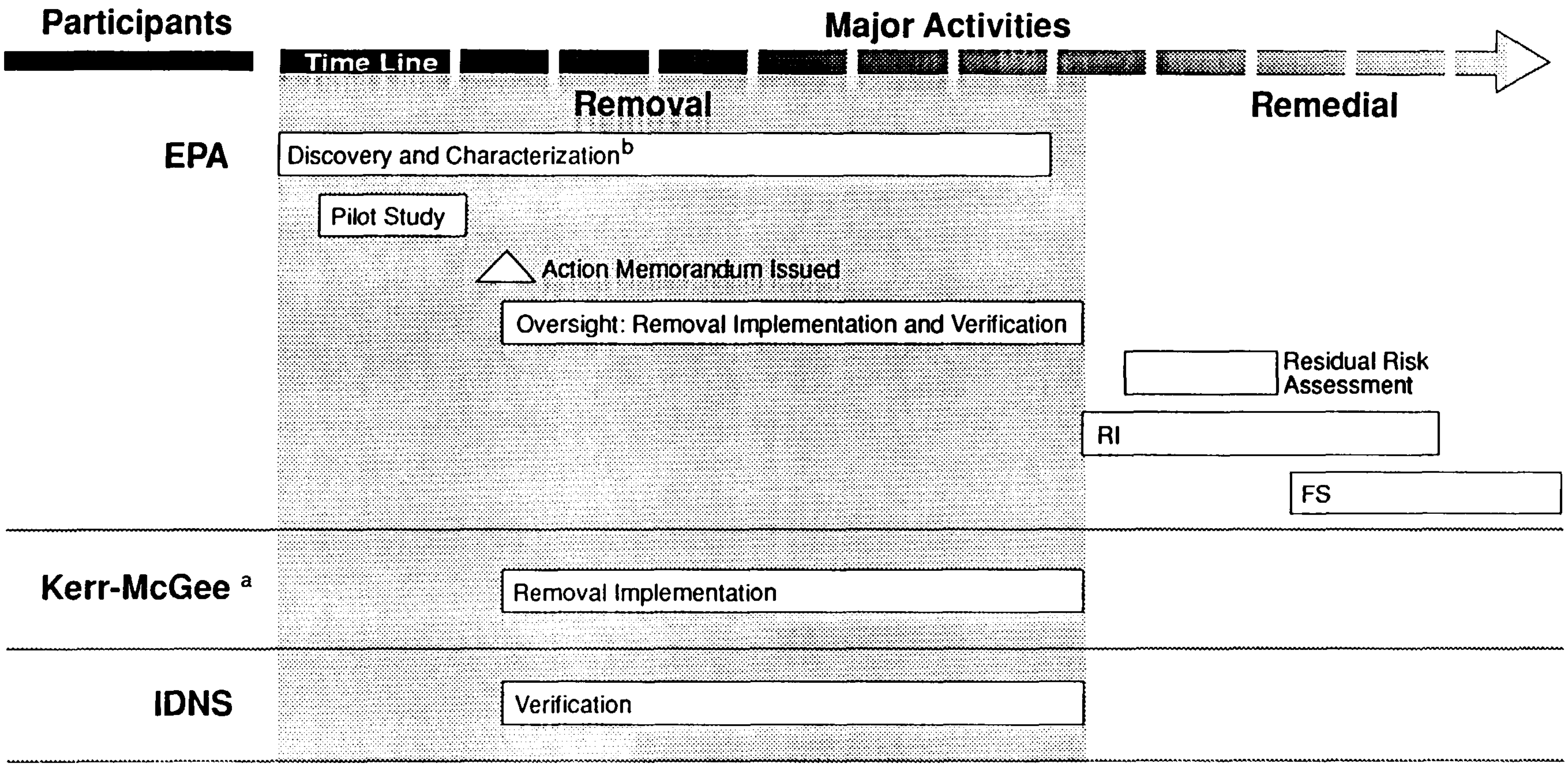
For the removal action, a discovery and characterization phase of investigation will be conducted to determine locations that are contaminated and that will undergo removal implementation. EPA has established conservative discovery criteria to minimize the chances of overlooking properties where contamination is present. The discovery criteria are based on outdoor soil activity concentrations, outdoor gamma exposure rates, indoor gamma exposure rates, and indoor radon/thoron decay product concentrations (see Appendix A).

The use of various monitoring technologies is being proposed to expedite the collection of information for the outdoor soil activity concentration and outdoor gamma exposure rates. A pilot study is being conducted by EPA in the early stages of discovery to determine the specific uses, correlations, and limitations of these monitoring tools as well as to quantify background and other soil conditions.

Characterization will be conducted on a particular property if the results of the discovery measurements for that property are conflicting or inconclusive, or if elevated results are suspected to originate from natural conditions (i.e., unrelated to thorium tailings) or interference from other areas. The type of characterization will vary with the cause of the uncertainty.

The project activities during the discovery and characterization phase of the investigation are designed to provide the maximum amount of information, as required by EPA, as efficiently as possible. Information from the studies will be periodically summarized and evaluated by EPA for a removal decision on the properties investigated. Only evidence of soil contamination related to thorium tailings material exceeding the discovery criteria will result in a removal decision. Elevated results will not necessitate removal if they result from natural conditions or other radioactive materials that are not related to the Rare Earths Facility.

If the results of the measurements indicate no contamination, the property may be a candidate for no removal. Removal implementation will begin only for the "discovered" properties, and only after the EE/CA has undergone public comment and an Action Memorandum has been issued by EPA. The Action Memorandum is a primary summary and decision document that substantiates the need for a removal action, identifies the



[a] *For project planning purposes, it is assumed that Kerr-McGee will be performing removal implementation.*

[b] *Discovery and characterization activities prior to completion of the pilot study will be limited to indoor radon/thoron decay product air sampling and gamma surveying.*

Figure 1-3
Major Activities and Participants
Residential Areas Site

proposed action, and explains the rationale for the removal action selection. For the purpose of preparing this EE/CA, it is assumed that through EPA's negotiations with Kerr-McGee, Kerr-McGee will conduct the actual removal actions in the field, and EPA will provide oversight of the removal implementation.

During and at the completion of a removal action at each location, IDNS will conduct a verification phase of investigation to confirm that the verification criteria (see Appendix A) for the removal action have been met. EPA will provide oversight of the verification effort.

When the discovery and characterization phase is concluded for a particular property, sufficient data will have been collected for deciding if a removal is warranted and for establishing general site conditions. However, uncertainties about nature and extent of contamination will remain. The discovery and characterization phase is not intended to eliminate all uncertainty, because experience has shown that for all but the simplest waste sites, the marginal value of collecting and analyzing "the next sample" declines rapidly once general site conditions are ascertained. Because of the basic complexity of a hazardous waste site and its associated uncertainties, engineers inevitably enter the implementation phase with many unresolved questions. The existing uncertainties need not hamper the removal action either by being ignored or by suspending removal implementation until the uncertainty is removed. The strategy presented in the Residential Areas site Work Plan (EPA, 1994) is to collect data during the implementation of the removal, as needed, to resolve the remaining uncertainties.

A corollary to the strategy that the detailed site investigation and removal implementation proceed concurrently (and after the EE/CA is written) is that the EE/CA does not benefit from a comprehensive site characterization. The EE/CA must rely on estimates and predictions based on past limited collections of site-specific data. The major uncertainty for the EE/CA is the volume of contaminated material.

Section 2
Site Characterization

This section provides background on the Rare Earths Facility as the source of the contamination for the Residential Areas site and the Kress Creek site (Section 2.1), describes the general physical characteristics of the Residential Areas site and portions of the Kress Creek site (Section 2.2), summarizes past site investigations and cleanup efforts (Section 2.3), and analyzes site conditions that justify a removal action (Section 2.4).

2.1 Background

From approximately 1932 to 1973, the Rare Earths Facility was operated as a thorium extraction facility for various purposes. Lindsay Light and Chemical Company operated the Rare Earths Facility from 1932 until 1958, extracting thorium and other elements from monazite sands, bastnasite (rare earth ore), fluorspar, and other ores. The nominal content of the ores was 0.15 to 0.4 percent uranium oxide equivalent, 4 to 8 percent thorium oxide, and 50 to 60 percent rare earth oxides. The ores were processed with sulfuric acid (H_2SO_4), hydrofluoric acid (HF), hydrochloric acid (HCl), or nitric acid (HNO_3) and, after 1969, with sodium hydroxide (NaOH) (EPA, 1986). The extracted elements, such as thorium, radium, uranium, and rare earths were supplied to private parties and the government. The site was also used for the manufacture of gas mantels (that contain thorium) and production of HF acid. Ownership of the processing facility changed through corporate mergers, becoming American Potash and Chemical Company in 1958, while the production of thorium continued. In 1967, Kerr-McGee purchased the facility and maintained operations until facility closure in 1973.

Production of thorium, a radioactive material, yielded radioactive tailings primarily containing Th-232 and residual levels of radium (Ra-226 and Ra-228). These tailings were stockpiled at the factory site and were available for use as fill material at residential and other properties throughout the West Chicago area, resulting in widespread surface and subsurface contamination of soils. In addition, piles of the material were subject to wind dispersal. In 1954, thorium production became subject to federal regulation with the passage of the Atomic Energy Act (AEA) by the U.S. Atomic Energy Commission (AEC). A license was granted in 1956 to Lindsay Light and Chemical Company and subsequently transferred with Rare Earths Facility ownership to Kerr-McGee in 1967. In 1974, under the Energy Reorganization Act, the AEC was abolished and the licensing and regulatory authority was transferred to the U.S. Nuclear Regulatory Commission (NRC). The State of Illinois petitioned NRC for amendment of the agreement-state licensing program to include licensing control of Rare Earths Facility material [categorized as 11(e)2 by-product material; see Section 4.1.7]. IDNS was granted licensing authority on November 1, 1990.

2.2 Site Physical Setting

Much of the site physical information discussed in this section (as well as past investigative information in Section 2.3) is taken from the *Remedial Investigation Report: Kerr-McGee Radiation Sites, West Chicago, Illinois* (EPA, 1986) that details a previous RI of West Chicago sites conducted by EPA; this document is not specifically cited elsewhere in the text but is listed in the Works Cited section. Other documents used to support individual statements are appropriately cited within the text.

2.2.1 Physiography

The City of West Chicago lies within the Great Lake and Till Plains sections of the central Lowland Provence, about 30 miles west of Lake Michigan. This portion of DuPage County is characterized by gently rolling topography with greater relief near rivers and creeks. Elevations in this part of the county range from 810 ft north of West Chicago to 700 ft southeast of West Chicago on the West Branch DuPage River. Properties adjacent to the Rare Earths Facility primarily include residential homes and commercial businesses. Much of the area is characteristic of a developed community where asphalt, concrete, buildings, and other structures exist.

2.2.2 Geology

The surficial geology of the region is characterized by glacial drift that was deposited by the Lake Michigan Lobe of a Wisconsinian-age glacier. The drift varies in composition from clay tills to gravels and sands. The thickness of glacial sediments ranges from less than 50 ft south of West Chicago to 150 to 200 ft north of West Chicago (Zeizel et al., 1962). The surficial stratigraphy is characterized by generally alternating layers of silts/clays and sands/gravels. At the bottom of the glacial drift is a laterally persistent basal sand comprised of gravel grading upward to sands and silts. Above the basal sand is clay/silt till. Above the till is a well-sorted sand and gravel outwash with some silt and clay. The sand and gravel outwash is laterally discontinuous and may not extend beneath the site. The uppermost unit overlying the outwash, or contiguous with the lower till where the outwash is absent, is a clayey till consisting of a poorly sorted clay/silt with some sand and gravel (Law Engineering Testing Company, 1981).

The bedrock geology of this region consists of alternating formations of dolomites, shales, sandstones, and siltstones.

The floodplain soils along the West Branch DuPage River, Kress Creek, and tributaries of the river are typically silty clay loams overlying sand and gravel or sands and silt, and some outwash and river sand and gravels along the West Branch DuPage River.

2.2.3 Hydrogeology

The four aquifer systems in the West Chicago area are the Glacial Drift, the Silurian, the Cambrian-Ordovician, and the Mt. Simon Sandstone. Based on the reported limited depths of contamination and low environmental mobility of thorium and its progeny, the site investigation activities do not include groundwater quality studies or hydrogeologic investigations. Details on the regional hydrogeology and groundwater use can be found in the RI report (EPA, 1986); these details are not included in this EE/CA because the site has not likely impacted the subsurface. Previous groundwater investigations have shown no evidence of thorium contamination [Sanford Cohen & Associates, Inc. (SC&A) et al.,1993].

2.2.4 Surface Water Hydrology

The DuPage River, located in northeastern Illinois within the greater Chicago metropolitan region, flows through Cook, DuPage, and Will Counties. The headwaters of the DuPage River consist of two branches, the West Branch DuPage River originating in Cook County and the East Branch originating in DuPage County. The land through which the DuPage River flows is characterized as topographically flat to rolling prairie with some marshy areas in the northern portions of the watershed. The DuPage River is a part of the 1,386 square mile Des Plaines River Drainage Basin as it flows in a southward direction approximately 58 miles (93.5 km) from its origins into the Des Plaines River at Channahon, Illinois.

The West Branch DuPage River, which flows from its origin in Cook County and through DuPage County and portions of Will County, is 28.3 miles long, has an average gradient of 3.7 ft per mile, and an approximate drainage area of 380 square miles (Northeastern Illinois Planning Commission, 1978). The West Branch DuPage River flows southward through forest preserve districts, agricultural lands, and urbanized areas toward its junction with the East Branch DuPage River.

In the study area, the West Branch DuPage River is fairly consistently 40 to 50 ft wide and 2 to 5 ft deep (Frame, 1984). At one point along the river's length, the east bank is bordered by a forest preserve and the west bank is bordered by undeveloped land and residential properties. The river has gravel banks and a stream bed that is stony and covered with vegetation.

From the headwaters, Kress Creek is 7.5 miles long, has an average gradient of 6.61 ft per mile, and an approximate drainage area of 19 square miles (Northeastern Illinois Planning Commission, 1978). The creek varies from 10 to 45 ft (Gunness Lake) in width and is generally 1 to 2 ft in depth (Frame, 1984). The creek banks are heavily vegetated in some sections and vary in height and slope, ranging from low to 2-ft vertical banks. The creek bed is mostly sand and rock with some regions of hard clay and limited amounts of aquatic vegetation (Frame, 1984). Along both Kress Creek and West Branch DuPage River, wet areas are connected to the water bodies only during high flows.

Kress Creek originates in an industrial area north of the Fermi National Accelerator Laboratory property. It flows on or near the Fermi Laboratory property and east and south toward the West Branch DuPage River. Beyond the boundaries of the Fermi grounds, Kress Creek passes under the Elgin, Joliet, and Eastern Railroad tracks, approximately 1,000 ft south of Route 38. Several feet beyond these tracks, a storm sewer outfall and trackside drainage ditch carrying water, including some from the Kerr-McGee Rare Earths Facility, empty into the creek. For the first 330 ft downstream from the storm sewer outfall, Kress Creek flows through undeveloped properties covered by trees and brush. Beyond the undeveloped property, the creek flows through a subdivision, between May and Joy Streets, where it expands to a width of 45 ft to form Gunness Lake. South of Joy Street the creek flows through open fields and a West Chicago park, beneath Wilson Street Bridge, through farmland and the grounds of a religious temple where it reaches Illinois Route 59. The creek continues its course beneath Illinois Route 59 and behind the Edgewood Walk Subdivision before reaching its confluence with the West Branch DuPage River.

The southern portions of the Residential Areas site study area are near either the West Branch of the DuPage River or Kress Creek.

2.2.5 Flow Patterns and Data

The U.S. Geological Survey (USGS) and the State of Illinois maintain two gaging stations in the West Branch DuPage River near West Chicago to measure discharge rates and water quality. One gaging station is located about 2 miles northeast of West Chicago, the other station is approximately 4 miles southeast of the city in Warrenville. Another gaging station is located in Kress Creek, near Joliet Street, slightly upstream from the confluence with the West Branch DuPage River.

The gaging station in the West Branch DuPage River upstream from Kress Creek has an approximate drainage area of 28.5 square miles. During the period from October 1985 to September 1990, the monthly average flows recorded at the station ranged from 47 cubic feet per second (cfs) in October to 75 cfs in March, with a yearly average of 67 cfs.

Downstream from Kress Creek, records at the Warrenville gaging station show that the West Branch DuPage River encompasses an approximate drainage area of 90.4 square miles at this station. During the period from October 1985 to September of 1990, recorded monthly average flows ranged from 107 cfs in July to 197 cfs in March, with a yearly average of 164 cfs.

The USGS records for Kress Creek were available from November of 1985 to September of 1990 and indicate that the creek has an approximate drainage area of 18.1 square miles. Monthly average flows ranged from 17 cfs in July to 40 cfs in August, with a yearly average of 26 cfs.

These records indicate that the stream flows within this region vary seasonally, with higher flows typically occurring in the spring from March until May or June, lower flows occurring in summer from July to October, and moderate flows occurring during the winter from November to February. As is typical with streams in the area, during high flow, surface water discharges to the groundwater, and during low flow, groundwater discharges to the surface water.

The average flows reported represent the net impact of several factors leading to substantial variability in the stream flows:

- Meteorologic conditions are highly variable. Average flow in any of the streams can vary an order of magnitude from year to year. Flows between drought and flood conditions can be expected to vary by several orders of magnitude.

- The drainage basin contributing flow to the stream also varies. Rapid urbanization in the past two decades can be expected to have substantially reduced low flows, increased high flows, and increased annual runoff volumes.

Flooding of the Kress Creek and the West Branch DuPage River is not uncommon. Heavy rains have been reported to cause Kress Creek to rise as much as 11 ft and overflow its banks from 200 to 800 ft total. Bank overflow occurs more frequently over the western banks of the creek and river.

2.2.6 Surrounding Land Use

The Kerr-McGee Residential Areas site encompasses residential, institutional, commercial, and municipal properties in and around the City of West Chicago, Illinois. Residential properties within the Residential Areas site study area are primarily located to the northwest, north, northeast, and south of the Rare Earths Facility.

The site area is generally single-family residential housing. The area surrounding the Rare Earths Facility is generally more high-density, single-family residential housing built prior to 1961.

Population along Kress Creek and the West Branch DuPage River in unincorporated West Chicago resides primarily in single-family home subdivisions. Homes exist in the May and Joy Street Subdivision along Kress Creek (Zone 2 in Figure 1-2), and in the Edgewood Walk subdivision (Zone 3), located along the West Branch DuPage River immediately south of the Kress Creek confluence. Many of these homes lie within the floodplain.

Much of the land area surrounding the West Branch DuPage River is forest preserve land, specifically, the Roy C. Blackwell Forest Preserve.

2.2.7 Climatology

The climate of the State of Illinois is typically continental with warm summers, cold winters, and frequent periods of temperature, humidity, and wind direction fluctuations caused by easterly migrating weather systems. The West Chicago area, situated about 30 miles west of Lake Michigan, experiences some climate modifications from the lake. The annual average temperature is 48.9°F.

The predominant wind direction is out of the southwest quadrant, with a predominance of generally westerly winds. The average wind speed is 11 miles per hour (mph).

2.2.8 Natural Background Radiation

Typical background gamma radiation exposure rates for the West Chicago area vary from about 5 microRoentgen per hour (μR/hr) to 13 μR/hr (Frigerio et al., 1978; Frame, 1984; Booth et al., 1982; IDNS, 1993).

The natural activity of Th-232 in soil in the West Chicago area has been reported as about 0.85 picoCuries per gram (pCi/g) by IDNS (1993), and as 1.6 pCi/g by Frame (1984). Under natural conditions, Ra-228, an alpha decay product of Th-232, is in secular equilibrium with Th-232; this means that the background Ra-228 level is also about 0.85 to 1.6 pCi/g. According to Booth et al. (1982), the background concentration for Ra-226, a daughter of U-238, is approximately 1.4 pCi/g.

Radon-222 (radon) and Rn-220 (thoron), which are noble gas decay products from the U-238 and Th-232 decay chains, respectively, are present under ambient conditions. These gases diffuse or migrate from soil and rock that contain the parent radionuclides. Because uranium and thorium are found naturally in most soils, radon and thoron are typically found in most buildings. The average indoor radon level in the U.S. is estimated to be about 1.3 pCi/L, and about 0.4 pCi/L of radon is normally found in the outside air. Levels in excess of 4 pCi/L are considered elevated according to EPA guidelines (EPA, 1993d); a regulatory standard for radon has not been established. The average indoor thoron level in the U.S. is estimated to be about 0.25 pCi/L, and average outdoor thoron levels are about 0.27 pCi/L (Li et al., 1992; Schery and Grumm, 1992). A regulatory standard for thoron has not been established.

Illinois and specifically the West Chicago area are unique because of generally high concentrations of Ra-226 in deep groundwater that are related to naturally occurring uranium deposits. Private wells screened in the shallow Silurian Dolomite Aquifer have been found to contain radium, thorium, and uranium levels near regional background levels taken from Lake Michigan (Fermi Lab et al., 1981). Radium-226 levels in municipal wells screened in the deep Ironton-Galesville [1,350 to 1,465 ft below land surface (bls)] were above background levels in Lake Michigan by one to two orders of magnitude because of natural radium, not because of thorium wastes. These levels were above EPA drinking water standards until the water was diluted with water from shallow wells (Fermi Lab et al., 1981).

2.3 Past Investigations and Responses

2.3.1 Residential Areas Site

Numerous investigations and response actions have occurred at the Rare Earths Facility and the four Kerr-McGee sites on the NPL. The most notable investigations and responses for the Residential Areas site include the following:

- Initial characterization and aerial radiological survey by Argonne National Laboratory (ANL) for the NRC (1976 to 1978)
- External gamma exposure rate survey by the NRC over selected areas [circa (ca.) 1981]
- Voluntary surveys and soil excavation by Kerr-McGee for 30 μR/hr exceedances (completed in 1985 for properties within city limits)
- Radon monitoring in 10 homes by ANL for EPA (ca. 1983)
- Second aerial radiological survey by EG&G for IDNS (1989)
- School and residential surveys by IDNS (1989 through present)

Each of these is summarized briefly below; general conclusions are presented at the end of this subsection.

Initial characterization by ANL for NRC. The initial base study to identify and briefly characterize properties outside the Rare Earths Facility was conducted from March 1976 to May 1978 by ANL for NRC (Frigerio et al., 1978). Frigerio et al. (1978) identified 75 thorium-processing waste deposits in this study; the sites included Reed-Keppler Park, the Sewage Treatment Plant, and Kress Creek, but also properties distributed to the east of the Rare Earths Facility. Fourteen of the sites identified were outside of the city limits. Techniques used to delineate the contaminated areas included an Aerial Radiological Monitoring Survey (ARMS) flyover in 1977, a street-by-street instrumented vehicle survey, an external gamma exposure rate survey, and soil contamination measurements using subsurface sampling.

External gamma exposure rate survey by NRC over selected areas. The NRC Office of Inspection and Enforcement, Region III, reported on external gamma exposure rates (at a 1-m height) at the Rare Earths Facility fenceline and surrounding residential neighborhoods to the north, east, and west of the Rare Earths Facility (NRC, 1981). Data collection indicated that exposure rates resulted from both on-Rare Earths Facility and off-Rare Earths Facility sources; however, the relative contribution of each was not established. Exposures to residents of the area were determined to be less than the NRC regulatory limits set forth in 10 CFR 20 applicable at that time.

Voluntary surveys and soil excavation by Kerr-McGee for 30 μR/hr exceedances. Kerr-McGee voluntarily initiated a program in the mid-1980s to survey essentially all properties in the city that might contain thorium residuals. Kerr-McGee specified an external gamma exposure criterion of 35 μR/hr at 1-m height for the discovery and mitigation of the contaminated properties. However, the discovery was implemented in the field using a criterion of 30 μR/hr so that properties with exposure levels at or slightly below 35 μR/hr were not excluded because of instrument variability. This criterion was for a gross measurement that included both natural background and any exposure from waste material. The field criterion of 30 μR/hr, minus a nominal background of 10 μR/hr (see Section 2.2.7), is equal to the value specified by EPA in 40 CFR 192 of 20 μR/hr for indoor gamma radiation greater than background.

Of the 2,733 properties surveyed within the city, this program detected residuals at 117 locations that exceeded the Kerr-McGee external gamma exposure criterion. (Section 1.3 mentioned that approximately 1,434 properties are located within the practical boundary of the Residential Areas site study area; thus, Kerr-McGee's surveys extended beyond the site's current planning boundary.) Contamination at the surveyed properties ranged from windblown material and spillage from trucks to apparent deliberate emplacement of residuals as backfill in yards and under structures.

Kerr-McGee, with assistance from the city, excavated 34,868 yd^3 (Denny, 1986) of thorium residuals from 116 of the 117 identified locations within the city by the end of 1985. [Seventy-one of the 75 sites identified by Frigerio et al. (1978) were accounted for in the Kerr-McGee program effort.] With few exceptions, the residuals were excavated until the exposure rate was reduced to background or below 15 μR/hr (Denny, 1985; Meldgin, 1986). The exceptions are residuals left under foundations at a few properties; several properties that may not contain residuals but where permission to survey the property for residuals was not given; a location where material is associated with the support walls for a swimming pool; a property where permission was not granted for removal of material from a backyard; and the Bolles Opera House at 185 West Washington (former laboratory and marketing facility) where thorium wastes were excavated from behind the building but contamination was left in the interior of the building (Denny, 1985; Meldgin, 1986). The RI report (EPA, 1986) indicates that even though thorium residuals indicating exposures above 15 μR/hr were left on some properties, the exposure rates prior to backfilling were often below 30 μR/hr. The thorium residuals were transported to and placed at the factory site for storage.

Surveys of properties in areas outside of West Chicago were initiated by Kerr-McGee in late 1985. Kerr-McGee did not remove these materials because the city would not allow thorium residuals from outside the city to be returned to the Rare Earths Facility.

Radon monitoring in 10 homes by ANL for EPA. ANL conducted indoor radon measurements in 10 homes for EPA ca. 1983 prior to any mitigation efforts (ANL, 1983). The radon and thoron working levels (WLs) were generally less than 0.02 WL in living areas. [One WL is the quantity of radon progeny in 1 L of air that will result in 1.3 x 10^5 million electron volts (MeV) of emitted alpha energy.]

Second radiological aerial survey by EG&G for IDNS. In 1989, EG&G conducted a second aerial radiological survey of West Chicago for IDNS. A map showing the boundary of elevated gamma levels was submitted to IDNS, but no supporting documentation was written. The results of the second aerial survey were used to define the boundary for the Residential Areas site study area (see Section 1.3).

School and residential surveys by IDNS. Beginning in 1989, IDNS has been performing screening-level surveillances of residential properties as part of its environmental program in and around West Chicago. These surveillances have generally consisted of outdoor gamma exposure rate surveys and sometimes a soil sample from the location on the property where the highest reading was obtained. Also, at the request of the school districts, IDNS conducted radiological surveys of seven school properties as well as outdoor radon/thoron and air particulate evaluations for several schools. In the period July 31, 1989, through August 12, 1993, IDNS has surveyed approximately 160 properties in the City of West Chicago and unincorporated DuPage County. Of these 160, 48 are categorized as "contaminated."

A preliminary focused risk assessment (see Section 2.4.3) was conducted and developed by EPA using three school properties and four residences identified and sampled by IDNS to determine the potential risk that might be expected to occur for a maximally exposed individual. Data used in the preliminary focused risk assessment shows Th-232 activity at the schools varying from 3 to 35 pCi/g, with external gamma exposures ranging from 3 to 11 μR/hr above background. Thorium-232 activities at residences included in the preliminary focused risk assessment varied from 28 to 780 pCi/g, with net external gamma exposures ranging from 52 to 590 μR/hr.

General conclusions regarding the site. Based on past investigations, the following general conclusions relevant to this EE/CA have been drawn from the data collected.

- Many of the contaminated sites were found in alleys, under streets, around buried pipelines, and in sections of private residents' yards. Thorium residuals were used around or under foundations in several homes (Frigerio et al., 1978; Denny, 1985 and 1986).

- Additional properties with elevated radiation exposure levels have been identified beyond those properties identified and remediated in earlier studies.

- Relatively few data are available with regard to thoron and radon gas or decay product concentrations in houses.

- In the previous removal, contaminated soil generally was limited to the top 2 ft of soil and often to the top 1 ft of soil.

- The radiological conditions (e.g., radionuclide concentrations in the soil and gamma exposures) are highly variable and heterogeneous at the properties investigated. The extent of contaminated material on the properties ranges from small, isolated hotspots to extensive deposits.

- Although properties located adjacent to the Rare Earths Facility had a somewhat higher frequency of contamination, a specific trend in distribution of contaminants at the Residential Areas site cannot be identified.

2.3.2 Relevant Portions of the Kress Creek Site

The primary sources of radiological data for the floodplain soils of the Kress Creek site are as follows:

- A walkover radiological survey along the waterways and banks of Kress Creek and the West Branch DuPage River (Frigerio et al., 1978)

- Comprehensive radiological surveys performed in 1981 and 1984 (Frame, 1984)

During the 1984 comprehensive radiological survey, the findings from the previous study were evaluated and incorporated. The area surveyed included a length of Kress Creek beginning at a location approximately 330 ft (100 m) downstream from the storm sewer outfall and extended to the confluence and approximately 660 ft (200 m) upstream and downstream on the West Branch DuPage River. Adjacent to the waterways, surveys extended a lateral distance of 80 ft (25 m) from each bank.

The Frame (1984) study results indicated the sediments in Kress Creek contained the highest levels of thorium contamination, where activities varied from less than 0.34 pCi/g up to 131 pCi/g in random locations throughout the length of the creek. Reportedly, thorium activity overall did not decrease with downstream reaches, but attenuated with depth. With the exception of the area located near the storm sewer outfall, ambient thorium activity was generally attained at approximately 1-ft depths. Near the outfall, thorium contaminant levels of approximately 50 pCi/g appeared constant to an approximate depth of 1.3 ft (40 cm). Along the West Branch DuPage River, the thorium activity in the sediments ranged from 2.24 pCi/g upstream of Kress Creek to 27.2 pCi/g downstream from Kress Creek, suggesting that the primary source of thorium contamination in the West Branch DuPage River is the sediments in Kress Creek.

The average ambient levels of naturally occurring thorium (total) in the floodplain soils adjacent to Kress Creek were 1.6 pCi/g. Generally, thorium activity in the floodplain soils were found to decrease with increasing distance from Kress Creek. The average total thorium concentrations in the soils at approximately 3 ft (1 m) distant from the Kress Creek bank reportedly were 26.1 pCi/g at the surface and 18.7 pCi/g at 1- to 3-ft depths. At a distance of 80 ft (25 m), thorium activity levels averaged approximately three times the ambient levels. The highest activity of thorium detected in the floodplain soils was 555 pCi/g at a depth of about 2 ft. Similar to the sediment samples, thorium concentrations in the soils adjacent to Kress Creek did not generally decrease with increasing downstream distance, but tended to decrease with depth. Maximum thorium activities in soils adjacent to Kress Creek and the West Branch DuPage River typically occurred at 0.5- to 1-ft depths, with a few exceptions. Also similar to the sediments, higher contaminant levels were noted at isolated upstream locations near the storm sewer outfall.

Along the West Branch DuPage River, the average thorium activities in the soils at approximately 3 ft (1 m) from the bank were 3.45 pCi/g at the surface and 3.98 pCi/g at 1- to 3-ft depths upstream from the confluence with Kress Creek. Downstream from the confluence, average activities were 12.5 pCi/g at the surface and 11.3 pCi/g at 1- to 3-ft depths. At a distance of 80 ft (25 m) from the bank, thorium activities were only slightly above the ambient levels.

Results from the direct radiation measurements generally followed the pattern of decreasing values with increasing distance from the banks, as noted in the isotopic analysis results. In general, exposure rates averaged four times the ambient levels at the creek edge and decreased to approximately 1.5 times the ambient level at a distance of 80 ft.

Systematic exposure measurements taken 3 ft above the ground approximately 3 ft distant from the Kress Creek banks averaged 28 μR/h and 14 μR/h at a distance of 80 ft. Along the West Branch DuPage River banks upstream from the confluence with Kress Creek, exposure measurements averaged 14 μR/h at a distance of 3 ft and 12 μR/h 80 ft from the banks. Downstream measurements averaged 36 μR/h at 3 ft and 20 μR/h at a distance of 80 ft. Systematic exposure rates measured near the surface in the same areas were generally about 20 percent higher. The beta-gamma surface dose rates (μrad/h) were found to typically range one to two times the measured surface exposure rates. The radiological walkover survey confirmed the general patterns identified by the systematic measurements. Values ranged up to 820 μR/h at the surface and 210 μR/h 3 ft above the surface.

2.4 Site Conditions that Warrant a Removal Action

2.4.1 Nature of Contamination

The waste materials transported off the Rare Earths Facility contain a wide range of constituents. The waste materials include tailings from a number of processed ores, possibly untreated ores, and other waste products from other process and manufacturing activities at the Rare Earths Facility. Numerous sampling and analysis programs have been conducted for the original waste materials at the Rare Earths Facility and for the

Reed-Keppler Park and Sewage Treatment Plant wastes. As mentioned, the radiological residuals include such contaminants as thorium and uranium and their progeny. Nonradiological waste components include mineral by-products that contain metals such as lead, barium, and chromium. Analytical results for soils at the Rare Earths Facility, Reed-Keppler Park, and the Sewage Treatment Plant indicate a wide range of concentrations of various radionuclides and metals, which in turn indicates a heterogeneous composition for the wastes.

2.4.1.1 Radiological Contaminants

The decay chains for U-238 and Th-232 are illustrated in Figures 2-1 and 2-2, respectively. These decay chains indicate the progeny and the half-lives for each isotope and principal particles (alpha or beta) emitted during the decay. Released gamma energy is also a significant component of some of the decays.

Uranium-238 transforms via alpha and beta decay to Ra-226, the parent of Rn-222. Radon is a noble (chemically inert) gas that may diffuse or migrate through solids and be released to the atmosphere. The daughters of Rn-222, such as Po-218 and Pb-214, are generally formed as ions that attach to particulates. The decay chain ends with stable Pb-206.

Thorium-232 alpha-decays to Ra-228, which transforms to Ra-224 via beta and alpha decays. Radium-224 is the parent of a noble gas, Rn-220, often called thoron to distinguish it from radon, Rn-222, produced in the U-238 decay chain. Thoron decays with a 56-sec half-life to Po-216, which transforms via several beta and alpha decays to stable Pb-208.

The ore processing procedures at the Rare Earths Facility fractionated the various radionuclides into different products and by-products based on the chemical characteristics of the various elements. However, EPA (1986) states that the analytical results from numerous samples indicate that the decay products are in relative radioactive equilibrium because of ingrowth and decay of the various decay products over several decades. In radioactive equilibrium, the specific activities (i.e., pCi/g) of the various decay chain radionuclides are approximately equal to each other.

The removal action criteria described in Section 3 are based on total radium in the soil (Ra-226 plus Ra-228). Radium is one of the few daughter products of Th-232 or U-238 that has a cleanup standard in soil. However, because the daughter products are generally assumed to all be in equilibrium, radium activities are excellent indicators of the presence of U-238, Th-232, and other daughter products. (To confirm or investigate U-238 equilibrium conditions, radiological soil samples collected from Kress Creek, Reed-Keppler Park, and the Sewage Treatment Plant will be analyzed for U-238 and its daughter, Ra-226, directly through alpha spectrometry. Results will produce U-238 to Ra-226 ratios from materials all originating at the Rare Earths Facility, and therefore, may be used to determine the degree of equilibrium between U-238 and its decay products in residential soils.)

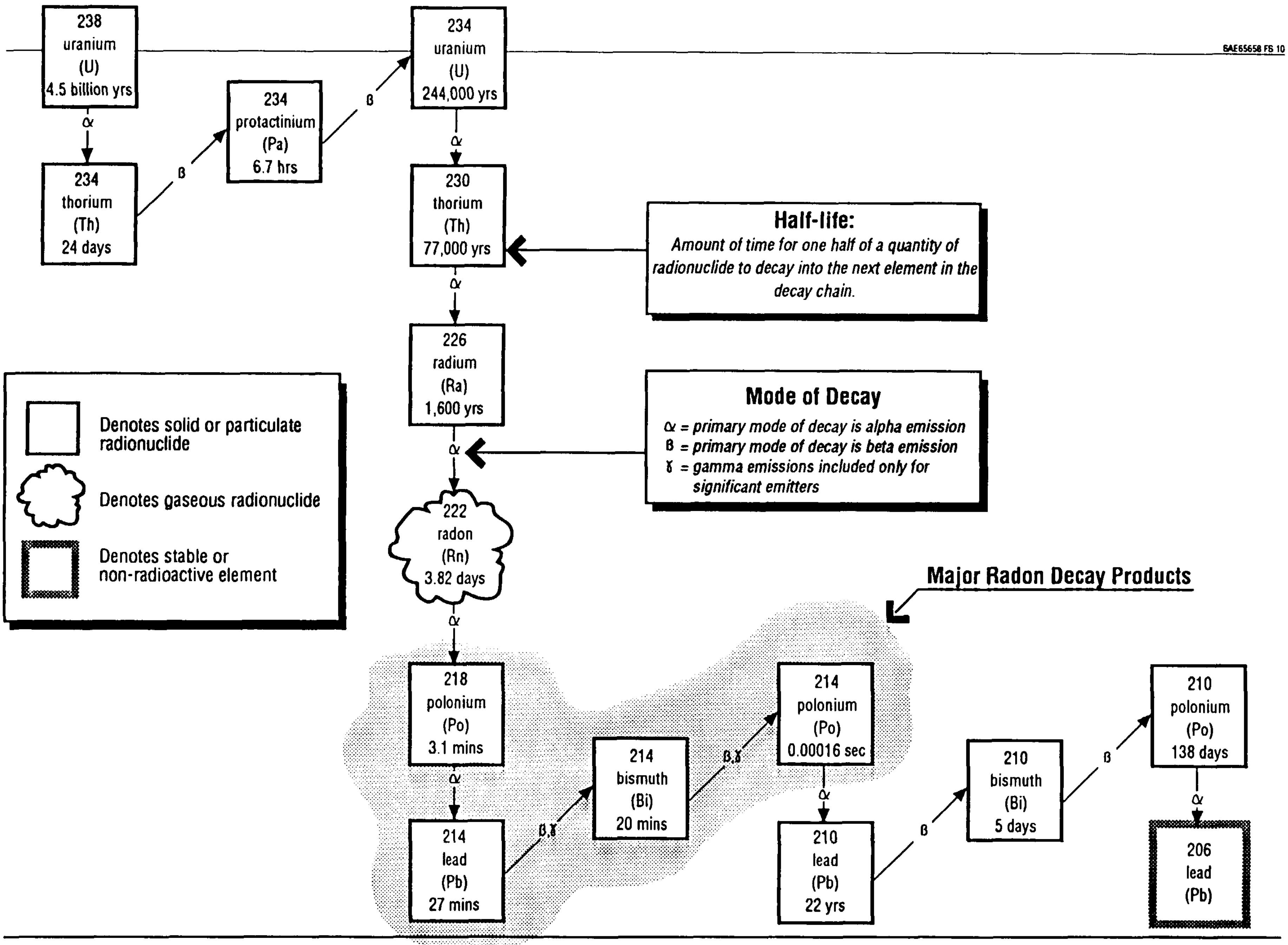


Figure 2-1
Decay Chain for Uranium-238
Residential Areas Site and Portions of the Kress Creek Site

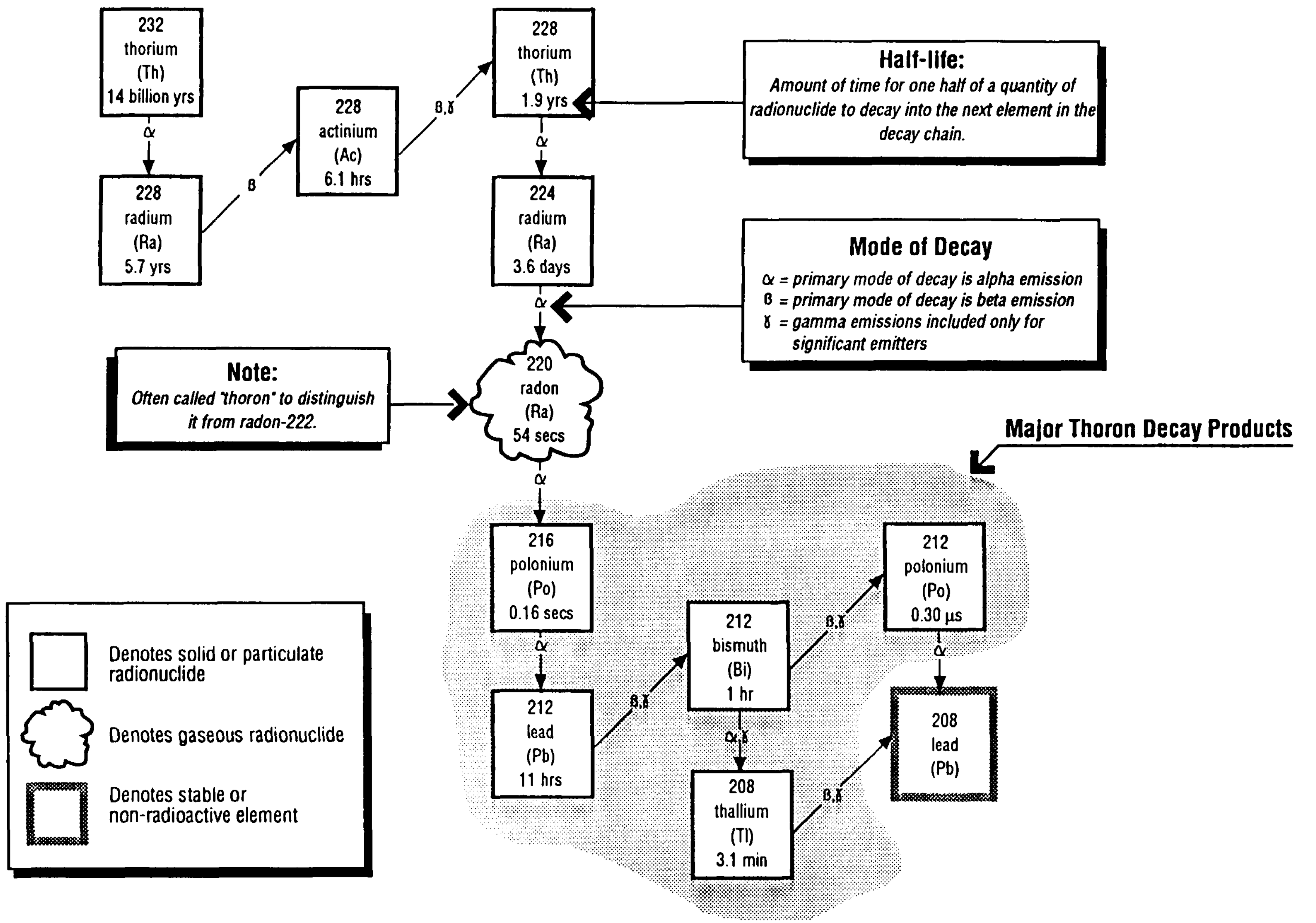


Figure 2-2
Decay Chain for Thorium-232
Residential Areas Site and Portions of the Kress Creek Site

The concentrations or specific activities of thorium and uranium and their decay products in the Residential Areas site and portions of the Kress Creek site are generally similar to those in the other Kerr-McGee Superfund sites. Because EPA (1986) reports that the nominal specific activities of U-238 decay chain radionuclides are approximately one-tenth of those for the Th-232 decay products at Reed-Keppler Park, the relative ratio of specific activities of uranium (and daughters) to thorium (and daughters) at the Residential Areas site and relevant floodplain soils is probably similar.

2.4.1.2 Metal Contaminants

Soils at the Residential Areas site and Kress Creek site have been analyzed in the laboratory for metals. However, the analytical results had not been evaluated prior to the publication and release of the EE/CA; thus, the suspected metal contamination has not been confirmed. The metals data for the Residential Areas site soils will be evaluated as part of the ongoing pilot study (see Section 1.4.2). The metals data for the Kress Creek site surface (floodplain) soils will be evaluated when the radiological analyses have been completed.

Metals have been found as co-contaminants with radionuclides at the Rare Earths Facility, Reed-Keppler Park, and the Sewage Treatment Plant, and because fill materials originated from the Rare Earths Facility, metals are expected in radioactively contaminated Residential Areas site soils and Kress Creek site floodplain soils. However, the Rare Earths Facility, Reed-Keppler Park, and the Sewage Treatment Plant may have significant sources of metal contamination other than those generated from ore processing; for example, Reed-Keppler Park and the Sewage Treatment Plant were landfills with multiple waste generators.

As an indication of which metal contaminants might be present, review of the findings at other Kerr-McGee West Chicago sites is useful. A preliminary comparison was made of metal analytical results from four Rare Earths Facility cores (Table 4-2 of EPA, 1986) with background results from 1993 Sewage Treatment Plant and Reed-Keppler Park sampling programs. Thirteen metals, grouped below by a health effect (carcinogen or systemic toxicant) and dietary importance (essential elements), were reported at the Rare Earths Facility at concentrations elevated above background:

- Potential carcinogen—chromium
- Systemic toxicants—barium, copper, lead, mercury, selenium, silver, thallium, and vanadium
- "Essential" elements—calcium, magnesium, potassium, and sodium

The elevated concentration of lead is not the result of thorium-series decay to stable lead, but is the result of Rare Earths Facility processing and/or the presence of lead in the Rare Earths Facility feed materials.

The concentrations of the elevated metals were next compared with their respective risk-based concentrations in residential soil [see EPA (1989 and 1991) for the lead cleanup level and EPA (1992) for the risk-based concentrations of the other metals] to predict which metals would be potential contaminants of concern from a health risk perspective. Most of the elevated metals have concentrations significantly below risk-based concentrations. Lead, a systemic toxicant with Rare Earths Facility concentrations ranging from 150 to 18,000 mg/kg, is an exception; the maximum lead concentration is higher than the interim soil cleanup level for total lead of 400 mg/kg (EPA, 1994). Thallium is also an exception, but is suspect because it was detected in only one Rare Earths Facility sample (of four), and was not detected at all at the Sewage Treatment Plant. Of those metals with concentrations that did not exceed their risk-based concentrations, barium was the closest (within a factor of four).

It follows from the above discussion that lead is a potential contaminant of concern for the Residential Areas site and portions of the Kress Creek site based on Rare Earths Facility soils data. However, the Residential Areas site and the Kress Creek site were listed on the NPL in part because of the (presumed) presence and threat from three metals: lead, barium, and chromium. For the purposes of this EE/CA, all three metals will be considered potential contaminants of concern, even though the Rare Earths Facility soils data indicate that barium and chromium will not exceed their respective risk-based concentrations.

Although some metals are considered potential contaminants of concern, metals data collection is not a principal focus of the site investigation. The reasons for this are as follows:

- Radiological constituents will have a significantly greater impact on risk because of their toxicity and expected concentration relative to metals.

- The relative ease with which radiological contaminants can be field monitored suggests that radiological contaminants may be used, with appropriate correlation, as a surrogate indicator of stable metals associated with the residuals and of the residuals in general. To the extent that the wastes composing the thorium residuals are intermixed or homogeneous and to the extent that the radionuclide and metal concentrations can be correlated, the radiation from thorium is a sufficient tracking measurement for all of the wastes, and hence a valid surrogate. If the wastes are very heterogeneous and if the lead and other metals are associated primarily with certain ores or waste residuals, the validity of the radiation surrogate assumption becomes questionable.

- For those alternatives incorporating final disposal, the presence of elevated metals in the waste is not expected to hinder or otherwise impact disposal of the 11(e)2 material or change the classification of the waste from 11(e)2 by-product material to Resource Conservation and Recovery Act (RCRA) or mixed hazardous waste (see Section 4.1.7).

Metals contamination at the Residential Areas site will be investigated during the pilot study and during waste disposal, but not during discovery/characterization unless the pilot study data prompts a modification of the site conceptual model (see Section 2.4.1). The pilot study will analyze for selected metals (e.g., lead, barium, and chromium) (1) to confirm the presence of metals as co-contaminants with radionuclides and (2) to confirm that radionuclides may serve as surrogate indicators for metals during the removal based on correlations of metal and radionuclide concentrations as a function of location.

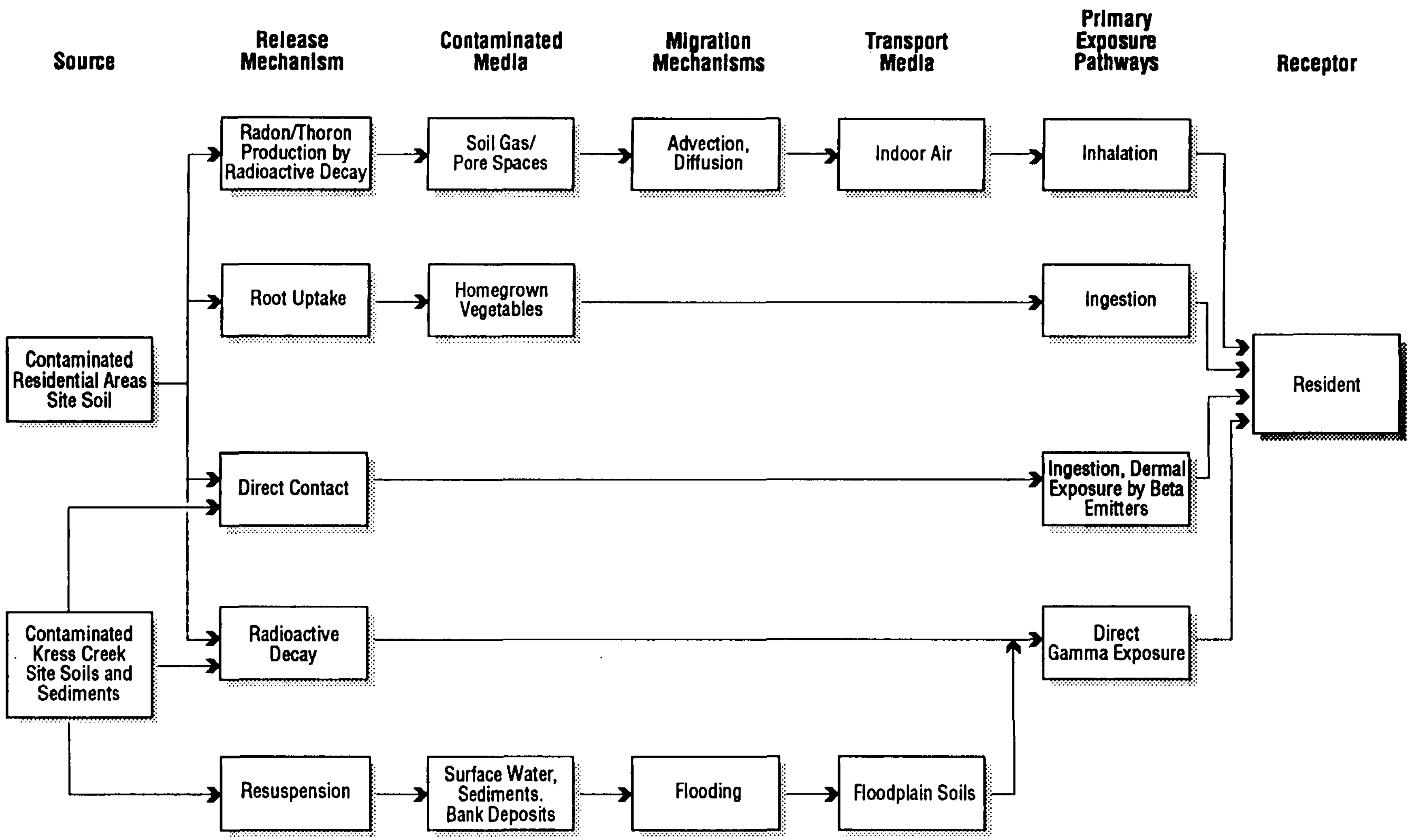
Preliminary information with regard to leachability can be extracted from EPA (1986), which reports that the Rare Earths Facility, Reed-Keppler Park, and the Sewage Treatment Plant samples were analyzed for EPA's Hazardous Substances List (HSL) analytes and evaluated using the Extraction Procedure Toxicity Characteristic (EPTOX) test. This test was used to assess the relative leachability of hazardous substances (including eight metals) in the waste under landfill-type conditions and to evaluate the potential for groundwater pollution. [EPA has since replaced the EPTOX test, previously referenced in 40 CFR 261, with a second-generation leaching procedure called the Toxicity Characteristic Leaching Procedure (TCLP).] Only small fractions of the metal concentrations available in the sample were leached by the EPTOX test, and the leached quantities were less than the EPTOX maximum concentrations established for the test. This indicates that the metals are in a form not easily leachable under "sanitary landfill" conditions that the EPTOX test was designed to model. (No inference should be made from the discussion of the EPTOX test that a sanitary landfill is being considered for the final disposal site.)

EPA reported that the EPTOX test was also performed for U-238, Th-232, and Ra-228, even though no specific EPTOX criteria were published for these constituents. However, the results indicate that the radionuclides tested, similar to the metals, are in a form with little potential for mobilization.

2.4.2 Conceptual Site Model

The current conceptual site model (Figure 2-3) is a framework within which the environmental pathways of potential concern are identified and illustrated. The media to sample for determining whether a release has occurred can be identified from this model. The model also serves as the framework for conceptualizing general response actions.

The model includes a set of hypotheses about the contaminated media and environmental pathways that are selected on the basis of existing data. For the focus of the removal action, the sources are contaminated Residential Areas site soil and Kress Creek site sediments and soil. Though not shown on the model, the original source of the contamination in the soil is the Rare Earths Facility, either as a result of tailings used as backfill or from wind blowing the material off the facility, or as a result of surface drainage and stormwater discharge to Kress Creek.



——— Probable Pathways

Potential contaminants of concern: Th-232 and U-238 and daughters, possibly lead, barium, and chromium

Figure 2-3
Current Conceptual Site Model
Residential Areas Site and Portions of the Kress Creek Site

A contaminant release mechanism is defined as any process that results in migration of a contaminant from a source area into the immediate environment. Once in the environment, contaminants can be transferred between media and transported away from the site.

The conceptual site model illustrates the various media, transport pathways, and exposure pathways that could be affected as a result of the residential soil contamination. Although this is specified as a model of current conditions, future conditions under a no-action scenario are expected to be similar. The land use is not expected to change in the future and, because the soil has been contaminated for up to 40 years, no new release mechanisms are expected in the future. Potential recontamination or continued buildup of contamination from windblown Rare Earths Facility material is not likely because the Rare Earths Facility waste piles are covered and protected, and the contaminated open land areas are covered with vegetation. However, the potential for windblown material may increase when each waste pile at the Rare Earths Facility is uncovered and excavated during the upcoming closure activities. The perimeter of the facility will be monitored and dust controls instituted as appropriate.

In the conceptual site model for the Residential Areas site, four release mechanisms for contaminants are as follows:

1. Gas release, molecular diffusion, and advection. Radon and thoron can be produced as a result of radioactive decay in the contaminated soil and then released into the soil pore spaces and to indoor (or other confined space) air.

2. Root uptake. Vegetables grown in the contaminated soil can uptake radionuclides into their mass.

3. Direct contact. The presence of the contamination in residential soils allows direct access to the contaminants without any release mechanism.

4. Radioactive decay. Gamma radiation can be emitted from the soil.

These release mechanisms allow for direct contact with the contaminants by the residents. However, they probably do not cause contamination of additional media.

The Kress Creek site adds a fifth release mechanism for contaminants: resuspension of sediments. Sediments can be resuspended by changing volumes/flow rates of surface water through Kress Creek and the West Branch Dupage River.

A potential release mechanism not included in the conceptual site model is erosion. Erosion resulting from surface water or wind has occurred in the past and has resulted in the contamination of soil that is considered part of the site. Further erosion is not likely for those developed areas with flat topography and vegetated or concrete/asphalt covers over most of the contamination, but erosion may still occur in undeveloped or disturbed areas. The impact of the small number of undeveloped or disturbed areas at the Residential Areas site or relevant portions of the Kress Creek site are expected to be minor.

Contaminant transport via runoff has impacted sediments and surface water (e.g., storm sewers and Kress Creek), neither of which are targets for the removal action. The Kress Creek site RI/FS will address sediment and surface water contamination, as well as floodplain contamination outside residential properties.

The low mobility of the contaminants and the surface deposition of much of the contamination means that leaching of contaminants at levels that would cause contamination of the underlying groundwater is unlikely. Additionally, split samples from groundwater samples collected at the Reed-Keppler Park site during the 1993 RI showed no evidence of other than naturally occurring radioactivity. Therefore, leaching is not included in the model.

Diffusion and advection of radon and thoron is the only potential migration pathway for the Residential Areas site. Because of the short half-life of thoron, the potential for migration indoors is low, although once thoron enters a home through foundation cracks or sumps, its long-lived decay product, Pb-212, may persist for some time and migrate quite a distance from the entry point. Some homes cleaned up by Kerr-McGee in the mid-1980s showed elevated indoor thoron decay product concentrations. Only indoor accumulation is considered a potential concern because of a possibility for accumulation of the radon to unacceptable levels in closed spaces.

Flooding is the only potential migration pathway for relevant portions of the Kress Creek site (i.e., contaminated floodplain areas within residential properties). Flooding is a concern because of its ability to continue to contaminate, or to recontaminate if cleaned up, any floodplain soils within residential properties.

The source of the contaminants in a flood would be resuspended Kress Creek site sediments and soils. Sediments in the Kress Creek site will remain a potential source of contaminants for the floodplain soils until the sediments are remediated. If the floodplains are cleaned up prior to the sediments, and then recontaminated during a flood, the recontamination would generally be in the form of a thin layer of contaminated sediments on the floodplain surface. It is impossible to predict with any certainty the frequency, severity, and impacts of flooding that may occur. In addition, the levels and extent of contamination that may result from such flooding is difficult to estimate.

2.4.3 Streamlined Risk Evaluation

This Streamlined Risk Evaluation (SRE) provides an evaluation of the potential risks of adverse health effects associated with site contaminants assuming a no further action (NFA) scenario. It follows recommendations provided in *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA, 1993b) for preparation of an EE/CA.

This SRE is not intended to be a full baseline risk assessment, but rather a limited evaluation using a more general approach including existing data and information.

Information from the preliminary *Focused Risk Assessment for West Chicago Vicinity Properties* conducted by EPA (SC&A et al., 1993) is used in this evaluation. The information in this SRE is intended to project the potential risk of adverse health effects that may occur if no removal action is taken. The objectives are (1) to discuss contaminants that lead to increased exposures; (2) to identify current or potential human exposures that should be prevented through a removal action; (3) to evaluate potential risks using existing data and information; and (4) to discuss uncertainties in the information presented. The results of the SRE are used to support a removal action decision.

2.4.3.1 Contaminants of Concern

Contaminants of concern are defined as those most likely to contribute to risk as a result of exposure. Because thorium ore residuals from the Rare Earths Facility deposited within the Residential Areas site and relevant portions of the Kress Creek site contained Th-232 and its daughter products and lesser amounts of U-238 and its daughter products, these are considered probable contaminants of concern as stated in Section 2.4.1.1. These constituents likely present the limiting risk. The actinium series radionuclides (U-235 and its daughter products) are not considered contaminants of concern. Based on the natural abundance of U-235, the actinium series radionuclides are not expected to be present except in concentrations much less than the Th-232 and U-238 series radionuclides. In addition, the primary exposure route of concern for these radionuclides is through dust inhalation; however, this is not expected to be a significant pathway of exposure given that the residential areas are heavily vegetated. Thus, it is believed that the actinium series radionuclides pose negligible risk in comparison to the limiting risk of the thorium and uranium series radionuclides. This will be evaluated in greater detail after data are received.

Other potential contaminants of concern for the Residential Areas site and relevant portions of the Kress Creek site include some metals. Metals are presumed to be commingled with the radionuclide contamination at these sites as a result of Rare Earths Facility thorium ore processing. As stated in Section 2.4.1.2, 13 metals were found at the Rare Earths Facility at concentrations elevated above background sample concentrations from the Sewage Treatment Plant and Reed-Keppler Park. Of these, only lead exceeded its recommended interim soil cleanup level, which is 400 mg/kg. Lead, barium, and chromium were initially identified as contributors to overall site risk and contributed to listing the site on the NPL. Although an evaluation of the metals data for the Residential Areas site and relevant portions of the Kress Creek site had not been performed prior to release of the EE/CA, and although the preliminary focused risk assessment did not address metals, for the purposes of this SRE, they are considered to be potential contaminants of concern.

The following brief discussion of the potential toxicological effects of both the radiological and potential metal contaminants of concern does not imply that the effects described will *always* occur in humans; such effects are dependent on, but not limited to, the contaminant concentration in a particular medium, exposure characteristics such as route and duration of exposure, and absorbed dose. This discussion is intended to provide a non-technical summary of the potential toxic effects associated with exposure.

General Hazards of Radiation Exposure. The effects of exposure to ionizing radiation from all of the radionuclides of concern fall into three general categories: carcinogenic, genetic, and teratogenic. Radiation produces damage in biological systems through ionization of molecules. Damage may occur directly, as when a chromosome breaks into smaller pieces after absorption of energy from radiation. Damage may also occur indirectly, through ionization of water molecules, to produce highly reactive free radicals. The free radicals may react with other cellular compounds and cause damage through oxidation reactions. For this assessment, the potential for cancer induction in the exposed individual is considered to have the most significant effect on health. Risks of genetic effects from radiation exposure to reproduction organs (i.e., exposure may produce adverse health effects in future generations) or of fetal (teratogenic) effects from radiation exposure to an unborn child (i.e., the exposure of a fetus may cause elevated frequencies of mental retardation or other adverse health effects) are considered less significant (EPA, 1989b). These assumptions are consistent with the current understanding of the effects of radiation.

Ionizing radiation is a demonstrated human and animal carcinogen. Data exist that correlate high exposures of radiation to cancer induction in humans. In general, scientists agree that the probability of cancer decreases with decreasing dose, but the dose-response model that predicts the effects of low-level exposure is still under debate. Current radiation protection standards are based on the idea that each increment of radiation exposure causes a linear increase in the risk of cancer. Significant uncertainty exists from extrapolating high-level information to low-level effects, but the models used are generally believed to be conservative (i.e., they will overestimate risks).

Uranium-238. The organs of most concern, as a result of uranium ingestion or inhalation, are the kidneys and bones. In addition to hazards from exposure to radiological emission products, uranium is chemically toxic to the kidneys.

The release of radon and subsequent decay products results in a potentially significant source of lung exposure—often referred to as radon decay product exposure. Radon-222 decays to Po-218, Pb-214, etc., which are particulate, short-lived decay products (see Figure 2-1). The most significant portion of lung exposure from inhalation of radon results from the alpha energy deposited in lung tissue by these short-lived decay products. In addition to lung exposure from radon decay products, uranium decay products also emit beta and gamma radiation. Gamma radiation exposes the entire body rather than a specific organ. Many of the uranium series radionuclides decay by beta particle emission. Skin doses from beta radiation may be possible if uranium series decay product contamination is present in soils on exposed skin surfaces.

Thorium-232. Thorium is relatively insoluble in water at environmental (near-neutral) pHs, binds tightly to the soil, and has a low uptake in plants. Therefore, thorium is generally less mobile in the environment than either uranium or radium. As mentioned, Th-232 decays to Rn-220 (thoron), which is a noble gas similar to Rn-222 (see Figure 2-2).

The gamma photon decay energies and number of photons emitted are greater for the Th-232 chain than for the U-238 chain. Hence, the gamma exposure rate per unit of activity for Th-232 is greater than for U-238. Thoron decay products have a lower adverse health risk in the lung than radon decay products (Ellett and Nelson, 1984; EPA, 1986). However, because the thoron decay product, Pb-212, has a relatively long half-life (11 hr), it has the potential to migrate out of the lungs to other organs of the body. As with uranium series beta emitters, skin doses may be possible if thorium series decay product contamination is present in soils on exposed skin surfaces.

General Hazards of Chemical Exposure. Two types of adverse health effects as a result of exposure to chemicals are described—carcinogenic effects and noncarcinogenic (or systemic) effects. Generally, chemicals exhibit primarily noncarcinogenic effects; however, some chemicals may exhibit both, with the carcinogenicity being the limiting effect.

The carcinogenicity of a chemical relates to its ability to interact with an organism's genetic material in a variety of tissues and organs and to produce abnormal cellular proliferation commonly called cancer. Cancer induction is considered by EPA to be a non-threshold effect (i.e., the risk of developing cancer increases linearly with each increment of exposure without regard to a minimum level below which risk is zero). In addition, the onset of cancer is believed to be a delayed response in many instances because symptoms do not occur immediately after exposure but rather several months or even years later. None of the chemical contaminants of concern are classified as carcinogenic via ingestion, which is considered the primary route of exposure for nonradionuclide contamination at the Residential Areas site.

Adverse toxic effects other than cancer may occur as a result of excessive exposure to certain chemicals. Noncarcinogenic or systemic toxicity may include injury or damage to tissues and organs as a result of inhibition or disruption of certain physiological or biochemical functions. Systemic toxicity may be classified as acute or chronic.

Acute toxicity refers to the rapid onset of symptoms after short exposure duration to relatively high chemical concentrations. This effect is most typical of inhalation exposure to high concentrations in air; however, exposure by ingestion to certain chemicals may also result in acute toxicity.

Chronic toxicity generally refers to a slower onset of symptoms as a result of continued exposure to low chemical concentrations. Such concentrations are termed sublethal because they are low enough not to cause immediate death. Chronic toxicity may be typical of both ingestion and inhalation exposure to very low concentrations of chemicals over long periods of time. It is this type of toxic effect that is of greatest concern with environmental contamination.

An assumption common to both acute and chronic toxicity is the concept of threshold, which is a level of exposure above which toxic effects would be manifested. This concept is used by EPA to develop a reference dose (RfD) for human exposure. An oral RfD is an estimate of a daily human ingestion of a chemical that is likely to be without an appreciable risk of adverse health effect (EPA, 1989b). This value is derived from animal dose-response experiments with various factors applied to correct for uncertainties in the animal data and to add a degree of conservatism in the value estimated for humans. When evaluating the risk of adverse health effects of exposures to a noncarcinogenic contaminant, the estimated intake via a particular route of exposure is compared to that contaminant's RfD. Generally, if an exposure to a chemical exceeds a chronic RfD, adverse toxic effects are likely to occur.

Below are toxicity profiles for each of the nonradiological contaminants of concern detailing the potential health effects and their RfDs.

Lead. Lead is the most common toxic metal in the environment. Naturally occurring lead concentrations vary with location, while anthropogenic lead releases have many sources. The principal route of exposure is ingestion of contaminated food and water and, to a lesser degree, incidental ingestion of contaminated soil. Inhalation of lead particulates is also an important route of exposure, although emissions from automobiles and other sources have decreased. Lead toxicity is dependent on many factors, with age and nutritional status predominating.

The most likely exposure to lead in the environment is associated with chronic exposure to low levels. This type of exposure can cause affects to the hematopoietic system, the nervous system, and the cardiovascular system. One characteristic effect of chronic lead intoxication is anemia as a result of reduced hemoglobin production and shortened erythrocyte survival. The most significant effect of lead exposure is nervous system impairment and dysfunction, particularly in developing fetuses and adolescents. Minor effects include reductions in hand-eye coordination, reaction time, visual motor performance, and nerve conduction velocity. More critical effects include encephalopathy and peripheral neuropathy. Lead can also impair the immune system. Epidemiological studies have indicated that chronic lead exposure may be associated with increased blood pressure in humans. Experiments involving lead exposures to animals suggests sterility in both males and females, spontaneous abortions, neonatal mortality, and morbidity. In some animal studies, exposures to high doses of lead salts have shown evidence of carcinogenic effects in the kidneys. Such evidence in humans is very limited and inconclusive.

Currently, no lead RfD has been approved by EPA. A default value for lead in soil has been recommended to guide remediation efforts. This value, 400 mg/kg, is based on ingestion of soil by a child in a residential exposure scenario (EPA, 1994).

Barium. Barium is present naturally in the environment and is found in nearly all plant and animal tissues. Its industrial uses are primarily in various metal alloys, paints, soap, paper, and other products. Exposure to barium may be via incidental ingestion of contaminated soil and inhalation of contaminated dust particles. The toxicity of barium compounds depends on their solubility. Soluble barium compounds are absorbed by the gastrointestinal tract after ingestion, and can cause paralysis, cardiovascular abnormalities, and gastroenteritis. Prolonged inhalation of barium particulates has resulted in baritosis, a benign, reversible pneumonia-like respiratory disease, seen primarily in exposed industrial workers.

The chronic oral RfD for barium is 0.07 mg/kg/day.

Chromium. Chromium is a naturally occurring element existing in several oxidation states of which only the trivalent and hexavalent forms are of biological significance. Although trivalent chromium is the most common form in both geological and biological materials, hexavalent chromium has been associated with most harmful effects. Chromium compounds, particularly sodium chromate and dichromate, are used in the production of chrome pigments and for production of chromium salts used in leather tanning, mordant dying, wood preservatives, and anticorrosive agents. The primary route of exposure is inhalation resulting from industrial releases, although ingestion of food, water, and soil contaminated from atmospheric or anthropogenic deposition may also occur. Chronic ingestion of hexavalent chromium has resulted in kidney damage in animals and humans. Dermal exposures can result in skin reactions such as dermatitis in sensitive individuals. Inhalation studies in chromate-producing industry workers have shown excess lung cancer incidence. Although most adverse health effects are associated with the hexavalent form of chromium, trivalent chromium is an essential element in trace quantities, primarily for carbohydrate metabolism. Chromium compounds in this valence state are much less toxic, are neither irritating nor corrosive, and are not considered to be carcinogenic.

The chronic oral RfD for chromium is 0.005 mg/kg/day.

2.4.3.2 Potential Receptors

Current residents living at single-family dwellings (children and adults) are considered the most important receptors. These receptors would have the greatest potential for exposure to the contaminants of concern on a daily basis as a result of normal activity patterns within the home and outside within the confines of their own property. An intermittent-type receptor, such as a trespasser or visitor, is not considered a potential receptor because of the much lower integrated exposure time.

No changes in receptors are anticipated because the study area is fully developed primarily with single-family residences. This land use is not likely to change in the future; therefore, current receptors may also describe future receptors.

2.4.3.3 Potential Exposure Pathways

A complete exposure pathway consists of three elements:

- A source of contamination and release mechanism
- A point of potential receptor contact with the contaminant
- A route of exposure (i.e., a method of access into the body)

Exposure pathways may require a contaminant transport mechanism if no receptors exist at the source of contamination. However, at the Residential Areas site and portions of the Kress Creek site, contaminant transport is not necessary because the soil of the residences is contaminated.

The conceptual site model shown in Figure 2-3 illustrates the completed primary pathways under current site conditions. Because the area is residential, it is assumed that future site conditions will be the same. As shown in the conceptual site model, the probable completed pathways of exposure include the following:

- Direct gamma exposure both inside and outside structures resulting from radioactive decay from contaminated soil outside structures

- Incidental ingestion of contaminated soil by children and adults

- Inhalation of radon and thoron progeny within enclosed structures (i.e., homes) emanating from contaminated fill material

Other potential exposure pathways, although less likely to be completed pathways, include the following:

- Ingestion of contaminated homegrown vegetables

- Dermal exposure to beta emitters from contaminated soils on exposed skin surfaces (this pathway was not evaluated in the preliminary focused risk assessment)

Inhalation of contaminated soil suspended into the air by mechanical action or wind is not considered a significant route of exposure because of the extensive ground cover.

2.4.3.4 Risk Characterization

The preliminary focused risk assessment developed by EPA evaluated the risks to a resident receptor associated with exposure to radionuclide contaminants using data collected from four residences. The risks to residents are those resulting from an assumed 30 years of exposure, including 6 years as a child and 24 years as an adult. It is based on limited survey and soil sampling data from seven representative contaminated properties (four residences and three schools) and conservative exposure assumptions. It is intended to present estimates of the potential range of current and future human health risks associated with activities conducted at these properties resulting from exposures to radioactive constituents in soil. The results of the preliminary focused risk assessment provide an indication of the general risk range that possibly may be present at the Residential Areas site and portions of the Kress Creek site (SC&A et al., 1993).

Data for the preliminary focused risk assessment include ground level radiological survey and soil sampling data collected by IDNS in June of 1989 and include Th-232 and U-238 and their progeny. Both of these radionuclides are assumed to be in secular equilibrium with their progeny; therefore, the activity of each progeny equals that of the parent (SC&A et al., 1993). As previously discussed, the data used in this assessment are limited; generally, only one soil sample was collected at each property from the area with the highest outdoor gamma exposure rate measurement. Maximum concentrations used in estimating intake were conservatively assumed to be homogeneous throughout the entire contaminated area (SC&A et al., 1993).

Maximum external gamma measurements at the residences ranged from 28 pCi/g to 780 pCi/g of Ra-228, a decay product of Th-232. Each of the four residences had external gamma exposures greater than 50 μR/hr above natural background (approximately 7 μR/hr), which was measured 1 m above the ground surface.

As previously discussed, all radioactive progeny of the Th-232 decay chain were assumed to be in equilibrium. In addition, it was assumed that the U-238 concentrations are only 10 percent of the Th-232 concentrations. This is based on the RI for the Kerr-McGee facility (EPA, 1986) and is supported by the analysis of samples for the properties addressed in the preliminary focused risk assessment (SC&A et al., 1993).

In evaluating risks, excess lifetime cancer risk is expressed in terms of a unitless probability of an individual developing cancer over a lifetime of exposure over and above that already expected. Because cancer risk factors are often upperbound confidence limits of the probability of a response (generally the 95th percentile), the excess lifetime carcinogenic risk estimates will also be an upperbound estimate. Therefore, the actual risk, which may not be known, will likely not exceed the estimated risk. The excess lifetime risk management range established in the NCP is 10^{-4} to 10^{-6}. The lower bound of this range (10^{-6}) means that the probability of an exposed individual developing cancer is 1 in 1,000,000. The upper bound of this range (10^{-4}) means that the probability of an exposed individual developing cancer is 1 in 10,000.

Total excess lifetime risk estimates from the preliminary focused risk assessment ranged from 3.1×10^{-3} to 7.6×10^{-4}. The risks varied depending on the contaminant concentration and extent of contamination at the individual properties studied. Individual pathway risks included ingestion of soil at 2.5×10^{-4} to 8.8×10^{-6}, ingestion of vegetables at 5.2×10^{-4} to 8.3×10^{-5}, inhalation of radon/thoron at 7.0×10^{-4}, and gamma exposure at 1.9×10^{-3} to 8.5×10^{-5}. As shown by the individual pathway risks, external gamma exposure during outdoor activities as measured by gamma dose is the limiting pathway. Inhalation of contaminated particulates contributed less than 1 percent of the total risk and is, therefore, not considered a significant pathway of exposure for the Residential Areas site and relevant portions of the Kress Creek site.

No evaluations were made in the preliminary focused risk assessment of exposure to nonradiological contamination. While it is evident that the radiological contaminants drive the site risk in excess of the risk management range, the contribution of metals to overall site risk is not known. [Preliminary removal goals (PRGs) for metals are discussed in Section 3.]

2.4.3.5 Uncertainties in the Preliminary Focused Risk Assessment

Several sources of uncertainties are recognized for the preliminary focused risk assessment:

- Characterization of site contamination
- Evaluation of exposure scenarios
- Use of radionuclide risk factors

Characterization of Site Contamination. Site contamination data used in the preliminary focused risk assessment are based on limited radiation surveys and single soil samples collected in the areas of maximum detected concentrations. In the focused preliminary risk assessment, EPA assumed that the maximum concentrations measured were homogeneous throughout the contaminated areas on the subject properties. Although this assumption may overestimate the risk level for some of the properties, EPA did not want limited data to cause them to underestimate potential risks from undetected contamination on the properties. In addition, surface coverings (asphalt, concrete, etc.) caused attenuation of the radiation exposure resulting, in many areas, in difficulty in identifying the highest radiation level. In the instance of soil samples, limited analyses were performed. They were generally analyzed by gamma spectroscopy; however, results were only reported for radionuclides related to Ra-226 and Ra-228. Secular equilibrium was assumed for all radionuclides in the decay chains (SC&A et al., 1993).

Adjustment factors and professional judgment were used in the calculations of intake and exposed dose to account for site-specific conditions such as size of contaminated area and amount of surface covering or overburden. The adjustment factors were necessary because the site characterization was based on limited radiation surveys, and the factors allowed EPA to make more reasonable estimates of the highest expected risks.

Because the contamination present at several of the properties is covered by overburden soil, the external gamma exposure rates measured were, in effect, reduced by a factor of 10 when compared to rates calculated assuming maximum soil concentrations. This reduction was caused by the shielding effect of the overburden soil. The approach of using actual measured gamma exposure rates provides a more reasonable assessment of present land use health risks. However, removal of the overburden soil would result in increased gamma exposure rate and increased risk (SC&A et al., 1993).

Evaluation of Exposure Scenarios. The characteristics of the actual exposed population are currently unknown. Therefore, conservative exposure scenarios were developed in the preliminary focused risk assessment to represent the population at the subject sites. This approach leads to upperbound risk estimates. Inclusion of a food pathway also leads to conservative estimates. Gardening and fruit trees occur on a relatively small scale in West

Chicago; however, the food pathway assumes that a significant fraction of the normal diet of fruits and vegetables for the West Chicago population is grown in the immediate area.

Use of Radionuclide Risk Factors. The risk factors used to convert intake or exposed dose to risk are derived from observations at high radiation doses; extrapolating the observed health effects to low dose levels presents a degree of uncertainty.

A toxicity assessment, as part of a baseline risk assessment, would provide detailed information concerning the uncertainties inherent in the radionuclide risk factors. This would serve to qualify these uncertainties and provide additional information for risk management decisions pertaining to removal actions and residual risk.

Section 3
Removal Action Objectives

This section addresses EPA's response authority and statutory limits (Section 3.1); the objectives and scope of the proposed removal action (Section 3.2); the removal schedule (Section 3.3); and regulatory requirements, advisories, and to-be-considered (TBC) guidance (Section 3.4).

3.1 Response Authority

EPA, as authorized by CERCLA and SARA amendments, intends to address the contamination problems at the Residential Areas site and portions of the Kress Creek site by removal actions to the extent practicable. However, EPA's actions under Superfund will be limited to those properties where the contamination originated from the factory (Rare Earths Facility) site. When naturally occurring radioactive materials not associated with Rare Earths Facility wastes are detected at levels exceeding EPA's action criteria (see Appendix A), any corrective actions must proceed through a mechanism separate from Superfund because Superfund generally does not give EPA the authority to remediate threats from naturally occurring substances (EPA, 1993).

The proposed expedited response action evaluated in this EE/CA is consistent with the overall cleanup strategy for the site and will not limit the choice of reasonable alternatives or prejudice the ultimate decision for which the follow-on RI/FS will be prepared. Thus, the removal action is an interim remedy that will be consistent with the final remedy.

3.2 Objectives and Scope

The removal action can be broadly defined as the management of contaminated materials at properties of the Kerr-McGee Residential Areas site and portions of the Kress Creek site. The removal action objectives (RAOs) for the site serve as the basis for identifying and evaluating appropriate response actions and alternatives that manage the contaminated materials.

The RAOs account for the nature and extent of the contamination, the conceptual site model, and the streamlined risk assessment discussed in Section 2. A brief summary of this information follows:

- The contaminants of concern are Th-232 and U-238 and their decay products. The action criteria for the removal action described in Section 3.2.1 are based on total radium in the soil (Ra-226 plus Ra-228). Additionally, the possibility of metals, particularly lead, barium, and chromium, as contaminants of concern will be investigated during the pilot study (previously discussed in Section 1.4.2) and as part of the residual risk assessment.

- The contaminated media of concern are the soil (as a result of particulate radionuclides and possibly metals) and the air (resulting from radon and thoron releases to indoor areas). Sediments and surface water associated with the storm sewers and the Kress Creek site are not addressed by the removal action, except as they relate to possible recontamination of floodplain soils through flooding. Groundwater is not a medium of concern based on available data.

- The primary release mechanism for the radiological contaminants is direct gamma emissions, which are directly measurable. Radon and thoron emissions are potential release mechanisms that will be measured through indoor air monitoring. Another mechanism is direct contact, which is measured by soils analyses. These release pathways are the principal foci of the removal action.

- Adults and children residing on the contaminated properties are considered the most important receptors under reasonable maximum exposure scenarios.

The RAOs for the removal action are consistent with the basic site action requirements under CERCLA and the SARA amendment. They include the following:

- Minimize potential health hazards to humans living or working on properties having contaminated soils.

- Minimize potential environmental impacts from the soil contamination.

- Be cost effective.

- Utilize permanent solutions and alternative treatment or resource recovery technologies to the maximum extent possible.

- Establish soil conditions that comply with all applicable or relevant and appropriate requirements [(ARARs); see Section 3.4] to the extent practicable. Under certain circumstances, an alternative may be selected that does not meet all the regulatory requirements; however, it must be protective of public health.

The properties currently considered for expedited response action under this EE/CA are those located within the study area boundary (see Figure 1-2) and found to be contaminated above EPA's action criteria. However, discovery and characterization will test the appropriateness of the boundary by investigating properties outside the boundary. In addition to the discovery and characterization methods, EPA is currently considering the use of other methods to investigate areas outside the study area. If any properties outside the boundary are discovered with similar contamination, they will be encompassed by the Residential Areas site for removal and will be included under the scope of this EE/CA.

As mentioned previously, the scope of the removal action includes only those contaminated soils or materials originating from the Rare Earths Facility; naturally occurring soils or materials with elevated levels of radioactivity not associated with Rare Earths Facility materials are not included in the removal action.

3.2.1 Removal Goals for Radiological Contaminants

Specific removal goals to meet the above objectives, with regard to the radiological contaminants in the soil, have been established by EPA in their *Action Criteria for Superfund Removal Actions at the Kerr-McGee Residential Areas Site: West Chicago, Illinois*, released in November 1993 (Appendix A). EPA's action criteria document in Appendix A explains how the criteria were derived, quotes the ARARs that form the foundation of the criteria, and provides rationale based on the "as low as reasonably achievable" (ALARA) principle for deviations from the ARAR. Table 3-1 summarizes the EPA action criteria to be used to verify completion of the removal action. These verification criteria serve as the removal goals for radionuclide contaminants in the soil.

3.2.2 Removal Goals for Non-Radiological Contaminants

Preliminary removal goals (PRGs) are initial cleanup goals that are protective of human health and comply with ARARs. No action criteria nor ARARs exist for metal constituents; however, the recommended interim lead cleanup limit in soil is TBC guidance in the evaluation. (TBC does not refer to potential ARARs; it refers to criteria, advisories, guidance values, and proposed standards that are not legally binding, but may serve as useful guidance for setting protective cleanup levels.) Therefore, PRGs are calculated for the metal contaminants of concern to serve as a basis for evaluating the potential impact to human health.

As previously mentioned, the correlation between radionuclide contamination and metal contamination will be evaluated during the pilot study. Metal concentrations derived from this study may then be compared to PRGs to evaluate whether concentrations may exist in soils commingled with a given concentration of radionuclides that potentially exceed health-based criteria.

Health-based PRGs for soil are calculated using the RfDs presented in Section 2.4.3 and following guidance in *Risk Assessment Guidance for Superfund, Part B: Development of Risk-Based Preliminary Remediation Goals* (EPA, 1991). Standard default exposure parameters were used assuming a residential exposure scenario that included only ingestion of soil and include an age-adjusted soil ingestion rate of 114 mg-yr/kg-day over an assumed exposure duration of 30 years.

Table 3-1
Summary of EPA Action Criteria for the Verification Phase

Topic	Unit of Measure	Background[a]	Criteria
Indoor thoron and radon decay product concentrations	WL (working level)	0.002 WL	Reasonable efforts must be made to achieve an annual average concentration (including background) in occupied buildings of no more than 0.02 WL; in any case, the concentration (including background) must not exceed 0.03 WL [40 CFR 192.12(b)(1) and 192.40(b)].
Outdoor gamma exposure rate	μR/hr (microRoentgen per hour)	5 to 13 μR/hr	After backfilling, the outdoor gamma exposure rates must not statistically exceed background at a distance of 100 cm from the surface [Illinois Administrative Code, Section 332.150(b)(2)].
Indoor gamma exposure rate	μR/hr (microRoentgen per hour)	Background data unavailable	Indoor gamma exposure rates must not statistically exceed background [Illinois Administrative Code, Section 332.150(b)(2)]. Note: This criterion will be used as a "finding tool" during verification to help determine if additional removal is necessary.
Radionuclide activity (concentration) in outdoor soils	pCi/g (picoCurie per gram) of dry soil	2.25 to 3 pCi/g[b]	Dry soil concentrations of total radium (Ra-226 plus Ra-228) must not exceed 5 pCi/g above background levels averaged over areas up to 100 m^2 in any 15-cm depth [based on relevant and appropriate portions of Illinois Administrative Code, Section 332.150(b)(1)].
General approach for removal action	Not applicable	Not applicable	Every reasonable effort should be made to maintain exposures and radioactive material quantities ALARA [Illinois Administrative Code, Part 340; 10 CFR 20; Department of Energy (DOE) Order 5400.5; NRC Regulatory Guide 8.37].

[a]Background values shown are approximate and are based on current available data. Additional background data will be obtained during the pilot-test and discovery phases of the removal.
[b]This background value is for total radium: Ra-228 at 0.85 to 1.6 pCi/g and Ra-226 at 1.4 pCi/g (see Section 2.2.7).

Table 3-2 shows the PRGs calculated for barium and chromium. As previously discussed, an RfD for lead is not available; therefore, a PRG cannot be calculated. The default for this is the recommended soil cleanup limit of 400 mg/kg that is considered protective for direct contact at residential settings (EPA, 1994b). The PRGs estimated for the other metals of concern, barium and chromium, are 11,641 mg/kg and 832 mg/kg, respectively.

Because of the potential commingling of radiological and metal contamination and because soil leachability tests indicate that the constituents are in a form with little potential for mobilization (Section 2.4.1.2), removal of the radiological component that exceeds the discovery criteria will effectively remove any metals present, most likely to levels much lower than their PRGs. The resultant site risk will then be approximately equal to the estimated risk associated with the radiological cleanup guideline or lower levels as achieved through the implementation of ALARA principals. Therefore, the contribution to overall site risk from metals would be negligible. This assumes, however, that a positive correlation exists between radionuclide concentrations and metals concentrations.

3.3 Removal Schedule

According to the aggressive schedule for this site, the pilot study, as well as some of the indoor (radon/thoron and gamma) measurements, will be completed prior to the release of the Action Memorandum, and the main portion of the site investigation (such as outdoor gamma measurements and soil sampling) will be well under way. The start of the removal implementation will lag several months behind the start of outdoor discovery activities, and the completion of removal implementation and verification activities is estimated to occur within several months of the completion of discovery activities, depending on the number of properties that are found to need removal action. In general, the discovery, removal implementation, and verification phases will proceed in series at individual properties but in parallel at the site as a whole.

The estimated duration of the removal implementation is less than 19 months. In consultation with EPA, this duration will be revised depending on the number of contaminated properties and volume of contaminated soils found at the site and the resources available for project allocation. EPA will be periodically advised of the budget and schedule status as the removal actions are under way.

3.4 Regulatory Requirements

Under CERCLA, the lead agency, EPA, identifies all ARARs associated with the contaminant, location, and the removal actions considered (40 CFR 300.400). One of the RAOs in Section 3.2 specifies that the removal action must attain these ARARs to the extent practicable. In determining whether compliance with ARARs is practicable, EPA may consider appropriate factors, including the urgency of the situation and the scope of

Table 3-2
Risk-Based Preliminary Removal Goals
Residential Exposure Scenario

Chemical	Oral RfD (mg/kg/day)	Soil Concentration at Target Hazard Quotient HQ = 1 (mg/kg)
Barium	0.07	11,641
Chromium VI	0.005	832

Exposure Assumptions:

Target Hazard Quotient	1
Ingestion Rate (mg-y/kg-d)	114 (age-adjusted soil ingestion rate, 30-year exposure)
Exposure Frequency (d)	365
Averaging Time (d)	10,950

the removal action to be conducted. Waivers [described in 40 CFR 300.430(f)(1)(ii)(C)] may be used for removal actions.

"Applicable requirements" are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, removal action, location, or other circumstances at a CERCLA site.

"Relevant and appropriate requirements" differ in that they are not directly "applicable," but they address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. In some circumstances, a requirement may be relevant but not appropriate for the site-specific situation.

In addition to ARARs, other TBC requirements may play a role in the selection and implementation of a preferred alternative. TBCs can include promulgated regulations that are not ARARs but still are useful in determining the necessary level of cleanup for protection of human health and the environment, or non-promulgated advisories or guidance issued by federal or state government. While actions conducted under Superfund are not required to meet TBCs, they can be useful in selecting between removal alternatives.

Three subgroups of ARARs can typically be identified: contaminant-specific, location-specific, and action-specific. Contaminant-specific ARARs address the particular pollutant under consideration, usually by way of a concentration limit. Location-specific ARARs are effective if the site conditions qualify for special consideration under a particular regulation (e.g., floodplains or wetlands). Some regulations, cited as action-specific ARARs, control the way in which a contaminated medium is handled.

A summary of the ARARs and TBCs potentially applicable to the Kerr-McGee Residential Areas site and portions of the Kress Creek site, divided into contaminant-, location-, and action-specific groupings, is presented in Appendix B; a final compilation of ARARs will be published in the RI/FS for the site. RCRA was not identified as a contaminant-specific ARAR, even with the possibility of elevated metals in the contaminated soils, because the definition of an 11(e)2 waste allows for the presence of process-related metals (see Section 4.1.7). However, RCRA may still be considered relevant and appropriate for action-specific activities.

Section 4

Identification of Removal Action Alternatives

Figure 4-1 shows the process used in this EE/CA to identify and analyze removal action alternatives for the Residential Areas site and portions of the Kress Creek site. This section identifies the alternatives, and Section 5 describes the analyses performed.

EE/CA guidance (EPA, 1993b) recommends that based on available information, only the most qualified actions that apply to a site should be addressed in detail in the EE/CA. A screening process against specified criteria "qualify" the general response actions for detailed evaluation. The use of presumptive remedies can, in many instances, provide rapid convergence of discussion and selection of preliminary alternatives, speeding the process by limiting the universe of identified actions. Presumptive remedies especially focus on those actions that have been applied and proven in the past at similar sites or for similar contaminants. Therefore, in concert with the EE/CA guidance, this section briefly describes general response actions applicable to radioactively contaminated soils and screens them to select the most qualified actions. Although example technologies associated with each general response action are sometimes mentioned, the screening process is performed for the response actions rather than at the level of detail required for the individual technologies.

This section summarizes the rationale for (1) identifying and screening relevant response actions that may be implemented for removal (Section 4.1), (2) combining response actions, as appropriate, into preliminary alternatives for the site to achieve the RAOs (Section 4.2), and (3) describing at a conceptual-level the preliminary alternatives (Section 4.3). Because of the nature of the contamination at the Residential Areas site and portions of the Kress Creek site, the number of practicable and suitable response actions and preliminary alternatives is limited.

4.1 Response Action Identification and Screening

General response actions potentially applicable for the removal action at the site properties include engineering controls for radon/thoron reduction, institutional controls, in situ containment, removal (excavation and restoration), treatment, interim storage, disposal, and recontamination prevention (Sections 4.1.1 through 4.1.8, respectively). The engineering controls and excavation address potential exposure to radon and thoron; all of the general response actions except for the engineering controls address contamination in the soil and the resulting gamma emissions. These actions are screened with regard to three broad criteria: effectiveness, implementability, and cost. The effectiveness of an action refers to its ability to meet the RAOs and goals; implementability is typically defined by its technical feasibility, including the availability of applicable technologies and its administrative feasibility; cost is used here as a relative ranking (e.g., high, medium, and low). Current

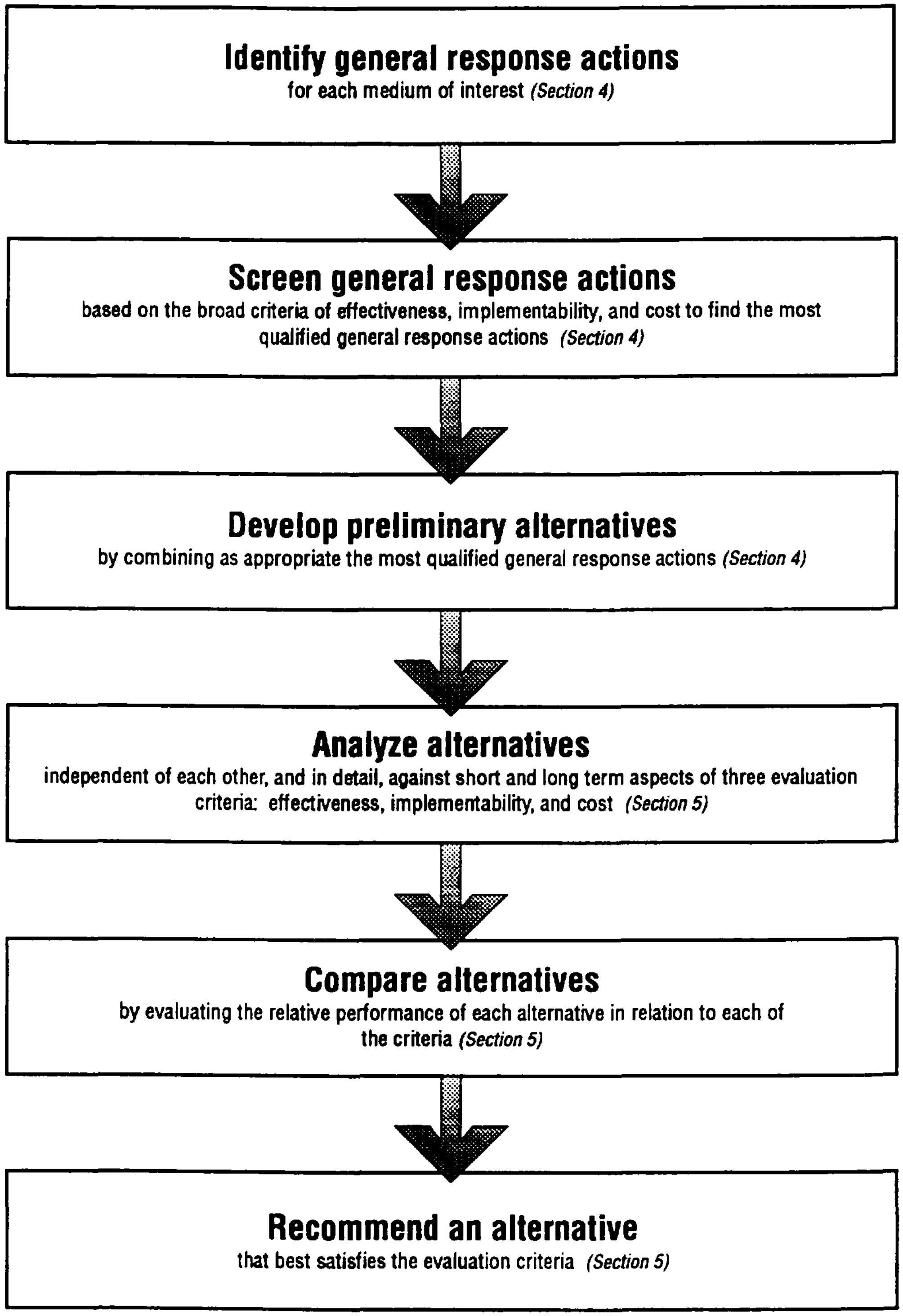


Figure 4-1
Process for Identification and Analysis of Removal Action Alternatives
Residential Areas Site and Portions of the Kress Creek Site

understanding of the contamination at the site properties and other general site conditions form the basis for the screening; property-specific conditions will be determined later during the discovery and characterization phases. Key considerations of the response action screening process are summarized in Table 4-1.

4.1.1 Radon and Thoron Reduction

To avoid indoor exposure to radon and thoron and their decay products from Rare Earths Facility-originating fill material, "engineering control" technologies may be implemented (1) to remove or dilute the noble gases from the air after they have entered a structure (e.g., ventilation in a crawlspace) and (2) to prevent entry of the gases into the structure (e.g., interior/exterior sealing to create gas barriers and soil gas ventilation/extraction to divert the gas before it reaches the structure). Combinations of reduction technologies may be required at certain properties. (Note: Soil removal, which also reduces radon and thoron concentrations, is discussed separately in Section 4.1.4.)

Screening comments on the radon and thoron reduction response action are as follows:

- This response action reduces human exposure to radon and thoron in indoor air. However, this action only addresses one effect of the contaminated soils—though a potentially significant one—but does not address the exposure pathways of direct contact, gamma exposure from the soil, or ingestion. For this reason, radon and thoron reduction technologies are best used in combination with other technologies that impact other routes of human exposures.

- Technical guidance on radon reduction technologies are available from EPA, and construction techniques for implementation are fairly standard with commonly available materials. There is no reason to believe that thoron reduction technologies will be substantially different from those for radon. With any system, the long-term maintenance and monitoring may be a public concern (e.g., an expense and inconvenience to property owners).

- Costs are considered to be low to moderate, depending on the combination of engineering controls used.

Engineering controls for radon and thoron reduction are not considered as exclusive removal actions that are used alone. However, engineering controls may be useful under special circumstances, such as the following:

- As a temporary measure to reduce inhalation risk where other more effective response actions (e.g., soil removal) cannot be implemented in a timely fashion; this could occur if discovery and characterization indicate a significant inhalation risk, but removal implementation at that particular location is delayed beyond the planned response time.

Table 4-1
Response Action Screening Summary

Technology	Effectiveness	Implementation	Cost	Evaluation
Radon and Thoron Reduction (Indoors) (see Section 4.1.1)	Reduces inhalation exposure only. No effect on other routes of human exposure.	Can be successfully applied using standard construction techniques.	Low to moderate	Rejected as a sole remedy, but may be useful for special situations where other actions are delayed or are not cost effective.
Institutional Controls (see Section 4.1.2)	Reduces exposure by regulating or restricting people's behavior or activities.	Difficult to implement, administer, and enforce at privately owned properties.	Low	Rejected as a sole remedy, but may be useful for special situations where other more active actions are inappropriate.
In Situ Containment (see Section 4.1.3)	Reduces exposure and/or contaminant movement; less effective for radon and thoron reduction.	Impractical for noncontiguous contamination in developed areas. Long-term monitoring, maintenance, and enforcement are difficult at privately owned properties.	Moderate	Rejected.
Excavation/Restoration (see Section 4.1.4)	Removes source of current and future exposure; fully complies with EPA's action criteria.	Can be successfully applied using standard construction techniques and conventional equipment.	High	Retained.
Treatment (see Section 4.1.5)	Volume reduction tests have only been partially successful. Immobilization is technically feasible but impractical.	The time required for treatability studies and additional testing of treatment technologies could delay the removal action several years.	High	Rejected.
Interim Storage (see Section 4.1.6)	Protects human health and the environment for the short term.	Interim storage will probably not be needed. However, a contingent action is to investigate the potential of using the Rare Earths Facility. No other offsite interim storage location is currently available or could be expected to become available within the time frame required for removal action.	Moderate to high	Feasible, but likely unnecessary.

Table 4-1
Response Action Screening Summary

Technology	Effectiveness	Implementation	Cost	Evaluation
Final Disposal (see Section 4.1.7)	Protects human health and the environment for the long term.	A commercial disposal facility is licensed for 11(e)2 by-product material. Prior to receiving the material, this facility will need to comply with pre-receipt conditions stipulated by the license.	High	Retained.
Recontamination Prevention (see Section 4.1.8)	A temporary measure that protects the relevant floodplains from possible recontamination and protects human health and the environment from redeposited sediments. However, the frequency, severity, and impact of flooding cannot be predicted with certainty.	Can be successfully applied using standard construction techniques; however, the design data needs and administrative requirements are significant.	Moderate	Sheet piling retained.

- As a long-term measure to reduce inhalation risk where other more effective response actions are precluded for social or institutional reasons or cannot be implemented in a cost-effective manner because of interferences from structures or utilities.

4.1.2 Institutional Controls

Institutional controls are intended to limit or prevent human exposure to hazardous environmental conditions by regulating or restricting people's behavior or activities. Controls could be implemented to impact activities of both current and future residents. Examples of activities that disturb contaminated soil that may need to be restricted include garden cultivation, belowground structural repairs, fence post digging, and pool excavation. Examples of institutional controls, which could be implemented alone or in combination, include physical barriers, posting of warnings (e.g., signs), use of deed restrictions or notification, resident relocation, and screening of permits (per municipal, zoning, and health ordinances) for construction and utility connections.

Though legally permissible and though these controls may reduce the potential for exposure to contaminated soils, humans affected by the institutional controls would need to be educated about the nature and intent of the controls to enhance the effectiveness. Other relevant screening comments are as follows:

- Some institutional controls require additional funding and personnel for implementation, administration, and enforcement. If enforcement by local authorities is not performed, compliance would depend on self-enforcement by residents. Some controls are subject to legal challenge and delay and could require compensation. Because many of the site's properties are privately owned and noncontiguous, implementability of institutional controls is difficult.

- Costs associated with institutional controls are generally low on an annual basis, but may increase significantly if resident relocation becomes necessary. The total cost for long-term implementation may also be significant.

For the abovementioned reasons, institutional controls are eliminated from further consideration as a sole remedy, but may be applicable in unique situations as a substitute for more active measures that are less appropriate for those unique situations.

4.1.3 In Situ Containment

In the context of this removal action, in situ containment consists of measures (1) to confine contaminated media at their present location, or (2) to place a barrier (or shield) between the contaminated media (or source) and the humans in the Residential Areas site and portions of the Kress Creek site. The purpose of the containment is to reduce the potential for contaminant movement and/or the associated potential for human exposure (e.g., exposure to gamma radiation and radionuclide ingestion). Containment for outdoor areas generally includes covering or capping contaminated surface soil with a geotextile fabric and a thin layer of soil and sod, and then properly maintaining the cover. Containment for indoor areas generally includes lead sheeting applied in layers to basement floors and walls until gamma radiation levels are reduced to the desired value. The sheeting would be covered with paneling or carpeting for aesthetic purposes and to prevent exposure to the lead.

Comments relative to using containment response actions at the Residential Areas site and portions of the Kress Creek site are as follows:

- This response action is effective at reducing the potential for contaminant movement and/or the potential for exposure through direct contact, gamma emission, and root uptake. However, containment is less effective for radon and thoron reduction.

- Containment for outdoor areas is generally considered impractical for the site properties because of the noncontiguous (i.e., hotspot) nature of the contamination, as well as the multiple soil penetrations (e.g., structures and trees) that may affect containment integrity.

- Actively enforced institutional controls and monitoring of long-term effectiveness are often included with this response action to guarantee that property owners will not remove or damage the containment. However, long-term controls and monitoring are difficult to implement because of the inconvenience to property owners and because those parties implementing the controls have no ownership rights (see Section 4.1.2).

- Costs are generally moderate.

The containment response action is inappropriate for the Residential Areas site and portions of the Kress Creek site and is therefore eliminated from further consideration.

4.1.4 Excavation and Restoration

This option involves excavation of Rare Earths Facility-originating soil contaminated at levels above the removal goals (see Section 3.2). The extent of contaminated soil requiring excavation varies from property to property. Removal has the following characteristics:

- Excavation segregates the contaminated soil from the public and is therefore effective at reducing human exposure for the long term.

- Excavation technology using standard construction procedures and conventional equipment has been successfully applied previously at the

Residential Areas site, as well as other similarly contaminated U.S. sites. The excavations are a significant inconvenience to the property owner, but the inconvenience is short term and the stigma of contamination is substantially reduced from future property transactions. Short-term risks from dust, runoff, or worker exposure can be minimized using proper controls.

- Costs are generally high; total costs will depend on the extent of the contamination.

Excavation (and restoration) is identified as an appropriate response action and is retained for further consideration.

4.1.5 Treatment

A limited number of in situ and ex situ physical and chemical options are available for treating radionuclides and metals in soil. They are as follows:

- Volume reduction via chemical recovery or physical separation
- Immobilization of soil contaminants via vitrification or matrix isolation (e.g., mixing and encapsulating with asphalt, cement, polymers, or resins). Immobilization processes bind the contaminants in a matrix to prevent their availability for transport or direct contact.

Costs for implementing these technologies are expected to be high.

At present, no in situ treatment technologies or series of in situ technologies have been proven to be viable and effective for treating radioactively contaminated soils in residential areas. The in situ treatments, whether volume reduction or immobilization, are generally impractical for application to developed areas with noncontiguous contamination. In addition, significant development is required for some in situ treatments for demonstrating feasibility in the field.

Immobilization, whether in situ or ex situ, is not a candidate for further consideration because (1) the immobilized waste forms are relatively ineffective in mitigating gamma exposure or radon/thoron pathways; (2) leachability studies (see Section 2.4.1.2) indicate that the radionuclide and metal contaminants, in their present form, are not easily leachable (i.e., they are already relatively immobile); (3) the mixing and encapsulating is often difficult to implement; and (4) waste volumes (for some technologies) would significantly increase. In situ immobilization has the additional inconvenience to property owners of having immobilized waste forms remaining near or at the property surface.

Electrical vitrification of contaminated soil to a glass matrix is an exception to two of the general disadvantages (Items 1 and 4) listed above for immobilization. Though still infeasible at this site, vitrification would probably eliminate the radon/thoron pathway, reduce (but not eliminate) the gamma exposure pathway, and reduce slightly the waste volume.

Volume reduction options include solids separation and size reduction techniques (such as mechanical screening and gravity separation) and soil washing, where contaminants are concentrated by mechanically and/or chemically scrubbing soils to remove contaminants. In soil washing, the washing agent becomes contaminated and must be handled as a secondary waste stream.

The selection of ex situ volume reduction technologies for soils contaminated with radionuclides is predicated upon particle size separation. Radionuclides and metals tend to adhere to fine-grained particles because of a higher surface area-to-volume ratio. In theory, if coarse- and fine-grained materials can be separated, treatment may be beneficial for lowering the transportation and disposal costs through volume reduction. Treatability studies must be conducted on a site-by-site basis to determine whether a relationship exists between radionuclide (or metal) concentrations and particle-size distribution.

In general, preliminary testing of volume reduction techniques for radionuclide-contaminated soils has thus far had only limited success. Eagle et al. (1993) reported that pilot-scale soil washing tests (with water) of radium-contaminated soil produced a "coarse" fraction with a radium specific activity (13 pCi/g average) that was 3 to 4 times lower than the specific activity of the feed soil (40 pCi/g). Richardson (1989) reported that multi-stage acid extraction studies of radium- and thorium-contaminated soil produced fractions with specific activities that were 10 to 17 times lower than the specific activity of the feed soil. The acid extraction studies were laboratory-scale tests performed on selected (optimized) soil particle sizes; no bench- or pilot-scale soil tests have been performed. Further acid extraction studies have not been aggressively pursued by vendors because of predicted implementation difficulties; examples include public acceptance and siting issues for a process performing heat-bleaching with acids in residential areas, and the potential mixed waste disposal issues for the washing agent.

As part of the closure process for the Rare Earths Facility, tests have been conducted on Rare Earths Facility site materials showing that radium activity is concentrated in the finer particles. The feasibility, design, and construction of a Physical Separation Facility (PSF) at the Rare Earths Facility has been studied as part of Rare Earths Facility excavation planning. Over a planned period of several years, this facility would separate and water-wash some of the excavated materials at the Rare Earths Facility using both wet and dry vibrating screens, a rotating wet scrubber, a thickener, and filter presses. Topsoil and clayey materials would not be fed to the PSF. The initial design specified blending of feed materials for the PSF to produce a resulting coarse-washed fraction decontaminated to a level less than 15 pCi/g above background. Recently, however, IDNS mandated an ALARA standard of 5 pCi/g above background for the Rare Earths Facility cleanup. The impact of this ALARA standard on the feasibility of the PSF, as currently designed, had not been assessed at the time the EE/CA was released.

Although soil washing may be proposed for the Rare Earths Facility materials, volume reduction of soils via soil washing from the Residential Areas site and portions of the Kress Creek site is not retained for further consideration because the process is not presently sufficient to reduce the contaminant concentration to levels below the soil concentration action criteria for a significant fraction of the waste. That is, if the average specific activity for (blended) site soils is greater than 20 pCi/g, as expected based on data from EPA's preliminary focused risk assessment, it would be difficult to achieve 5 pCi/g above background. The topsoil and clayey fractions expected in the site soils also discourage application of soil washing. Additional pilot testing would be required before serious consideration could be given to implementation. If a pilot treatment scheme was eventually successful, either a treatment facility could be built or the PSF could be considered for use, depending on availability of the PSF, its appropriateness for use, and EPA's policies regarding feeds blending and disposal of the coarse fraction. A treatment facility other than the PSF would take considerable time to site, design, construct, permit, and start up, delaying the removal perhaps years.

CERCLA favors treatment options, and EPA will continue to monitor the progress and feasibility of treatment technologies.

4.1.6 Interim Storage

The excavated soil must be placed in either interim storage or shipped offsite for final disposal (see Section 4.1.7). Interim storage would be necessary only if final disposal becomes unavailable or is delayed for a prolonged period of time. Interim storage involves consolidating all of the excavated material and temporarily placing that material in one or more areas of a storage site until final disposition of the wastes is determined or becomes available. Options for interim storage include (1) placing the bulk material in piles and covering the piles or (2) containerizing the material and stacking the containers. Covering the piles or, to a greater degree, containerizing the material reduces the potential for leaching or for airborne contamination; however, storing additional radioactive material on a site does add to the total external gamma exposure emanating from the storage area. (Note: The total gamma exposure does not increase linearly with the amount of stored radioactive material because the material forming the outer layer of the pile/stack significantly attenuates radiation emitted from the pile/stack interior.)

The interim storage location could be the Rare Earths Facility or some other, as yet unidentified, offsite facility. Costs range from moderate, if the Rare Earths Facility becomes licensed by IDNS to receive and temporarily store the soil from the Residential Areas site and portions of the Kress Creek site, to high, if other offsite locations must be identified, approved, purchased, secured (to prevent entry to the area), and licensed. The time frames for implementation of the two interim storage options also range from short to long, respectively; indeed, the time frame to engineer and license an offsite (i.e., non-Rare Earths Facility) interim storage facility may delay the removal action several years and would, therefore, disqualify the offsite facility as a valid option.

Storage of contaminated soils at the Rare Earths Facility was accomplished by Kerr-McGee during their excavation of residential properties in the mid-1980s. Interim storage has also been accomplished at other similarly contaminated U.S. sites. An option, therefore, is to place the contaminated soils from the Residential Areas site and portions of the Kress Creek site at the Rare Earths Facility, with the understanding that (1) the waste storage will be temporary and (2) EPA will probably require (for administrative rather than health physics reasons) that the soil from the Residential Areas site and portions of the Kress Creek site be kept segregated from other contaminated soils from the Rare Earths Facility or other Kerr-McGee sites. Though interim storage is technically feasible, it will only be considered in the event that disposal (as described below) is delayed (e.g., the disposal site is not ready to accept waste) or waste transport is delayed (e.g., the railspur at the Rare Earths Facility is not yet constructed).

4.1.7 Disposal

Disposal refers to the permanent offsite placement of contaminated waste in a manner that protects human health and the environment for the long term. Disposal costs, including transportation of the waste to the disposal facility, are high.

Given the time frame for the removal action, the only disposal option considered for further evaluation in this EE/CA is a licensed commercial disposal facility; disposal alternatives with lengthy time requirements (e.g., developing and siting a new facility) will not be considered for the removal action.

The contaminated soils at the Residential Areas site and portions of the Kress Creek site are classified as "by-product material," which, according to the AEA of 1954, as amended, means "the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content" [AEA, Section 11, paragraph (e), number 2]. Under authority of the AEA, NRC has developed standards and regulations for disposal of these so-called 11(e)2 by-product wastes.

Disposal options for this category of waste are limited. A separate license is required for a facility to take this category of waste. While many disposal sites have at one time had a license for 11(e)2 material, most have had specific qualifications for acceptance. For example, many sites have obtained a license to accept a specific shipment of this type of waste. Others accept only from specific sites, usually a site that is owned by the owner of the disposal site. Still others have the capability of accepting this category of waste, but do not have a general license for acceptance; they obtain specific licenses as necessary.

One disposal site, the Envirocare Facility, currently possesses a general disposal license for 11(e)2 material. Any other active 11(e)2 disposal site would have a license with specific waste acceptance criteria and would need a license amendment to handle and dispose of Superfund 11(e)2 waste from West Chicago.

The Envirocare low-level waste (LLW) facility in Tooele County (near Clive, Utah) possesses a general license for 11(e)2 waste. This license was obtained in November 1993 and is probably the most complete license ever issued for disposal of 11(e)2 material. Disposal methods include the Super Sacks (1-yd^3 containers with drawstring closures), B-25 metal boxes, or bulk disposal. Kerr-McGee currently has a contract in place with Envirocare, and this waste would be covered by the provisions in the contract; charges for disposal at the Envirocare facility are established in the contract. Laboratory confirmation testing of the waste is required prior to acceptance at Envirocare.

Envirocare can accept 11(e)2 by-product material having an average concentration below 2,000 pCi/g for any radionuclide in the uranium series or below 6,000 pCi/g for any radionuclide in the thorium series in any truckload or railcar. The presence of elevated metals suspected to be commingled with the radionuclides in the soils should not hinder disposal of the soil as an 11(e)2 waste. Elevated metals are common co-contaminants in this type of waste and are taken into account by the licensing agency (e.g., NRC and the State of Utah) in granting an 11(e)2 waste disposal license. Envirocare has indicated that if it can be demonstrated that the elevated metals originated with ore or the ore processing, the metals are exempt from RCRA even if they were to exhibit the "characteristic of toxicity" based on TCLP results. The current groundwater quality discharge permit from the State of Utah for the facility places concentration limits on metals; however, Envirocare reports that the limits are higher than any of the maximum concentrations indicated in the RI report (EPA, 1986) for any of the Kerr-McGee sites.

Envirocare's license imposes various administrative conditions; radioactive material qualification requirements; operational controls; inspection, monitoring, and recording requirements; and reporting requirements that Envirocare must meet in order to accept the waste. The license states that 120 days advance notice of shipment should be allowed prior to the first 11(e)2 shipment to allow Envirocare to prepare for waste receipt and to comply with NRC pre-receipt requirements. However, because of ongoing efforts by Envirocare and Kerr-McGee with regard to disposal of the Rare Earths Facility wastes, much progress in waste receipt preparation and compliance has already been made. Envirocare started construction in May 1994 of an 11(e)2 waste "cell" at their facility and should, according to current schedules, be prepared to accept 11(e)2 waste from the Rare Earths Facility in September 1994. The ongoing preparation means that advance notice of shipment of 11(e)2 waste from other sites, such as the Residential Areas site, should be minimal.

Disposal is retained for further consideration.

4.1.8 Recontamination Prevention

This response action to flooding minimizes risks of recontamination to portions of the Kress Creek site (i.e., the floodplain soils on residential properties) after cleanup. If the stream water rises above the banks, it could deposit contaminated sediments. If these contaminants exceed EPA's action criteria (see Section 3.2), additional cleanup would be required. Because flooding is unpredictable, the frequency of flooding that could occur between completion of the removal action for the floodplain soils and remediation of the rest of the Kress Creek site is indeterminate. To be effective as a recontamination preventative, this response action must be implemented before a flood occurs.

The alternative to prevention is to save the cost of implementation and accept the risk and possible additional cost of a second cleanup during the Kress Creek site remediation. Examples of "post-flooding" cleanup activities are excavation/restoration or high-pressure water rinsing (sediments deposited in residential areas would be rinsed back into the stream with fire hoses to removal action goals) with downstream sediment control barriers. Details of final costs, quantities, scheduling, and resident acceptability would be considered during the Kress Creek site RI/FS. The cost of a second cleanup would vary depending on the extent and frequency of flooding.

Several recontamination prevention technologies were screened and evaluated on a preliminary basis using engineering judgment and approximate costs based on experience. They are summarized as follows:

- Creek Diversion. This option reroutes creek flow using ditches or trenches to bypass residential areas. Because the creeks contain base groundwater flow at times, full diversion cannot occur. Additional difficulties with this option include securing property through which alternate channels could be constructed to bypass the residential areas, the high cost of construction, possible contamination of the new channels requiring subsequent remediation, and loss of aesthetics of the existing stream. The ecological and permitting issues would also be formidable. Diversion is not recommended for this response action.

- Berms or Dikes. Berms and dikes are compacted earthen ridges or ledges constructed along the creek banks to keep flood waters from reaching residential areas and depositing sediment. This option is technically feasible and effective, but it requires a lot of real estate for the berm slopes, and the berm construction would generate a lot of heavy equipment traffic during installation and later removal. Berms are not recommended for this response action.

- Sheet Piling. Though somewhat expensive, this option is attractive because it requires very little space, it can be removed when no longer needed with minimal disturbance, and it can probably be decontaminated for reuse. Some economy is realized by the recovery of the sheet piling. It would be considered aesthetically unpleasing by the residents, but may be acceptable as a temporary measure. This technology is retained for further consideration.

Implementation of this contingent technology is technically feasible, uses standard construction techniques and equipment, and assures that Alternative 2 remains protective of public health and the environment over the long term. In addition to protecting the cleaned residential areas, it serves as a barrier between the stream and residents, reducing exposure of potential receptors to stream sediments. One disadvantage is that the time required to address data needs and administrative requirements may significantly delay implementation. Sheet piling is retained for further consideration.

4.2 Identification of Preliminary Alternatives

In this section, the general response actions that passed initial screening in Section 4.1 are combined into preliminary alternatives. The general response actions considered potentially applicable to the Residential Areas site and portions of the Kress Creek site include the following:

- Indoor radon and thoron reduction (considered only for special removal situations where other actions are delayed or are not cost-effective)

- Institutional controls (considered only for special removal situations where more active actions are inappropriate)

- Excavation/restoration (to fully comply with EPA's action criteria)

- Interim storage (at the Rare Earths Facility)

- Disposal (at a licensed commercial facility)

- Recontamination prevention (using steel sheet piling)

Based on consideration of the various benefits and liabilities from the range of possible response actions, as well as the potential for impedances to implementation, the response actions were combined to form the following preliminary removal action alternatives:

- **Alternative 1—No Action.** This alternative postpones action at the Residential Areas site and portions of the Kress Creek site until their respective RI/FS has been completed and the Records of Decision (RODs) have been issued.

- **Alternative 2—Source Removal.** This alternative consists of expedited excavation of the contaminated soil from properties (both the Residential Areas site and portions of the Kress Creek site), backfill and restoration of the properties, packaging of the waste (if needed), transportation to the disposal site, and final disposal. Engineering controls to reduce radon and thoron concentrations, as well as specific institutional controls, may be used at a relatively small number of properties if excavation is inappropriate. Recontamination by flooding of floodplain soils on residential properties, if any, will be cleaned up during the Kress Creek site RA. This alternative is described in more detail in Section 4.3.

- **Alternative 2, Contingent Action A – Interim Storage.** This contingent action consists of interim storage of the excavated soils at the Rare Earths Facility in the unlikely event that transportation or disposal is delayed. This contingent action is described in more detail in Section 4.3.5.

- **Alternative 2, Contingent Action B – Off-Rare Earths Facility Staging Area.** This second contingent action for Alternative 2 (discussed in Section 4.3.6) is not based on a review of the response actions but is instead a response to a possible situation where the Rare Earths Facility is unavailable for use as a staging area for excavated soil from the Residential Areas site or portions of the Kress Creek site. A description of this alternative is postponed in the EE/CA until waste transportation for the base alternative (Alternative 2) has been described (Section 4.3.2).

- **Alternative 2, Contingent Action C – Recontamination Prevention.** This contingent action is a temporary measure to prevent/reduce recontamination of floodplain soils on residential properties. It consists of installing steel sheet piling between Kress Creek and the residential properties in Zone 2 (this zone is shown in Figure 1-2) and between the West Branch DuPage River and the residential properties in Zone 3. This contingent action is described in more detail in Section 4.3.7.

4.3 Conceptual-Level Description of Source Removal Alternative

This section describes at the conceptual level how the source removal (Alternative 2) might occur. The specific implementation of the general process described here is not unique and does not preclude the removal action contractor from altering implementation techniques as needed. The purpose of the description is to provide a basis for the alternatives evaluation in Section 5. Some of the quantity/volume assumptions made in the description are subject to relatively high uncertainty but are necessary for cost estimating purposes.

4.3.1 Excavation and Restoration

Contaminated soil in excess of the action level (i.e., 5 pCi/g total radium above background) will be excavated. The amount of excavation at a property could vary from removal of a small hotspot to removal of most of the surficial soil. The boundaries of the excavation would be determined from existing radiological data and then monitored with supplemented surveys during the removal. An access agreement between the property owner and the contractor (or other responsible party) would be obtained prior to start of the excavation. An emergency safety plan would be coordinated with local police, fire, utility, and emergency personnel.

Excavation in open areas will be performed with conventional earthmoving equipment (e.g., backhoes, bulldozers, scrapers, small bobcats, and front end loaders). Those areas with limited access for conventional equipment, such as immediately next to or underneath structures, will be excavated using procedures that support and maintain the integrity of the structures and utilities. In some cases, the excavation will be manual. It is assumed that the excavation (and backfill) near structures or utilities (confined areas) is 2-1/2 times more costly than open-area excavation, and that 10 percent of the total quantity excavated for the site has near-structure ramifications (90 percent is from open-area excavation). In many instances, it is expected that the excavation and restoration could be performed without temporary relocation of residents.

In some situations where contamination is found underneath a structure, it may be necessary to move the structure (trenching methods as an alternative to moving the structure may also be used), provide underpinning, or break up and remove the basement slab. Utilities (e.g., gas, water, and sewer) would need to be removed and replaced if house moving, underpinning, or deep excavation in the front yard of a property were necessary. If utilities are interrupted, a household would have to be temporarily relocated for an assumed average period of 60 days.

Upon receipt of data indicating that the property has been cleaned to appropriate levels, excavated areas will be replaced with clean fill and the properties restored, to the extent possible, to the same condition that existed prior to the excavation and in accordance with property owner's agreements.

Special operating procedures during the excavation will increase the excavation cost and duration over that expected from standard construction scenarios; these procedures include decontaminating equipment, minimizing dust and dust inhalation, controlling runoff, and monitoring radiation exposure. Verification tests by IDNS after the excavation, as well as after restoration, will also be necessary for the removal action to meet the verification criteria (see Section 3.2). The property owners will receive documentation giving results of data collection and removal implementation on their property.

4.3.2 Packaging and Transportation

As the contaminated soil is excavated, it will be readied for shipment at the property. Bulk (unpackaged) shipment of the soils is allowable under transportation regulations and is a viable option for the removal contractor, but is not required because soils treatment is not currently an option for the removal action. Soils packaging does increase the handling cost slightly, but also permits inspection of waste quantities of consistent size. Both bulk and packaged shipments have been performed at other sites in the U.S.

Although bulk shipment is not precluded from consideration at the Residential Areas site or portions of the Kress Creek site, the packaging option is assumed for the source removal alternative and the contingent actions to provide a consistent basis for estimating costs. Use of the packaging option (1) avoids the licensing requirement for using an off-Rare

Earths Facility staging location if the Rare Earths Facility were unavailable for staging (see Section 4.3.6) and (2) reduces the number of controls/measures needed to prevent contaminant transport during interim storage (see Section 4.3.5), if needed.

The excavated soils from a property would be fed into the top of a hopper located on the same property. The hopper diverts the soil through chutes into 1-yd^3 durable polypropylene bags, which are then tied off by laborers. The bags are then pushed along a roller conveyor to a location where health physics personnel scan the bags so that the activity concentrations are below 2,000 pCi/g, the lower limit established by the U.S. Department of Transportation (DOT) for defining radioactive materials. Identification tags containing survey data and location references are attached to the bag for tracking purposes.

A loader or crane then picks up the bag and places it into a lined dump truck. When the truck is full, the load is covered and secured, the truck is radiologically surveyed prior to leaving the property, and then the truck hauls the soil to a Rare Earths Facility staging area or transloading site next to a railroad spur that runs along the western side of the Rare Earths Facility. All of the study area is within a radius of approximately 2 miles from the Rare Earths Facility. Transportation routes would be established to minimize impact on the community. When sufficient quantities of material have been collected at the staging area, the railcars are loaded (each "gondola" railcar holds approximately 75 bags or 75 yd^3) and the material is shipped. Because of the range of waste volumes possible for the Residential Areas site and portions of the Kress Creek site, truck transport to the disposal site would be more expensive than rail transport.

4.3.3 Final Disposal

The waste will be transported to a licensed offsite disposal facility. For purposes of this EE/CA, it was assumed that waste would be transported approximately 1,300 miles via rail to the Envirocare facility near Clive, Utah, for final disposal. Samples will be taken of the waste periodically during the removal action to verify to Envirocare that the waste meets their waste acceptance criteria for 11(e)2 by-product material.

4.3.4 Waste Volumes

Because comprehensive characterization of the Residential Areas site and portions of the Kress Creek site will occur subsequent to the submittal of this EE/CA, the extent and depth of contamination cannot be estimated for the EE/CA with any reasonable degree of certainty. To provide a basis for the alternatives evaluation, and specifically the cost estimate for the source removal alternative (Alternative 2), four volumes have been selected to represent a potential range of soil excavation; these four volumes (labeled as waste volume scenarios 1 through 4) and their rationale are presented in Table 4-2.

Table 4-2 Waste Volume Scenarios for Source Removal Alternative			
Scenario	Contaminated Properties[a] (number)	Contaminated Properties[b] (as percent of total)	Excavated Volume[c] (yd^3)
1	50	3.5	15,000
2	100	7	30,000
3	200	14	60,000
4	400	28	120,000

[a]A range for the number of contaminated properties (50 to 400) was selected for cost estimating and alternatives evaluation purposes. The actual number of contaminated properties will not be determined until discovery and characterization are complete. Current site information is incomplete; however, a database printout (dated October 26, 1993) of West Chicago properties surveyed by IDNS and Kerr-McGee lists 87 "contaminated" properties without excavation dates. These are properties that are likely to exceed EPA's action criteria but were not excavated by Kerr-McGee in the mid-1980s. Survey data indicate exposure rates above Kerr-McGee criteria for 57 of the 87 properties and below the criteria for the remaining 30.

[b]The percentage of contaminated properties is determined by dividing the number of contaminated properties (second column) by the total number of properties (approximately 1,434 properties) within the boundary of elevated gamma readings (see Section 1.3). The range of percentages shown (3.5 to 28 percent) reflects (1) the percentage of properties identified by Kerr-McGee in the mid-1980s with survey data exceeding the excavation criteria (i.e., 117 contaminated properties out of 2,726 properties surveyed, or 4.3 percent), and (2) the percentage of above-background properties identified by IDNS in the time interval 1989 through 1993 (i.e., 48 contaminated properties out of 160 surveyed, or 30 percent).

[c]The excavated volume may be calculated one of two ways (both ways provide the same answers):
(1) Multiply the number of contaminated properties (in Column 2) by 300 yd^3 of excavated soil per property. This figure of 300 yd^3/property is the approximate average volume excavated per property by Kerr-McGee in the mid-1980s (Denny, 1986): 34,868 yd^3/115 completed excavations = 303.2 yd^3/ excavation.
(2) The following assumptions are used for this calculation:

- The average property size is 13,000 ft^2. Most of the residential properties range in size from 10,000 to 17,000 ft^2. The average value of 13,000 ft^2 was determined by dividing the total area within the flyover contour (approximately 692 acres) by the number of properties within the contour (approximately 1,434 properties), and then multiplying by a factor of 0.6 to account for public areas such as streets and railroad lines.
- The average extent of contamination for each contaminated property is 25 percent of the surface area. The percentage of contaminated area within a property was estimated by analyzing 23 radiological survey maps produced in the mid-1980s during the Kerr-McGee excavation.
- The average contamination depth is 2 ft.
- Soil in the ground increases in volume or swells by a factor of 1.25 when excavated due to loss of compaction.

Calculation: Number of properties (in Column 2) $\times$ 13,000 ft^2/property $\times$ 0.25 $\times$ 2 ft depth $\times$ 1.25 $\times$ 1 yd^3/27 ft^3 = volume (yd^3).

4.3.5 Conceptual-Level Description of the Interim Storage Contingent Action

In the event that the proposed methods of rail transport or permanent disposal become temporarily unavailable or delayed, one possible contingent action is to place the excavated soil from the Residential Areas site and portions of the Kress Creek site in interim storage at the Rare Earths Facility. For the purposes of the EE/CA, the contingent action assumes that:

- Kerr-McGee is licensed by IDNS (Illinois is an Agreement State for NRC) to receive and store soil from the Residential Areas site and portions of the Kress Creek site at the Rare Earths Facility. The licensing agreement will stipulate waste management protocols and indicate that the waste will be shipped from the Rare Earths Facility within a prescribed period of time. An additional stipulation may prohibit consolidation of the waste with other waste at the Rare Earths Facility. (If the waste were stored in bulk form, measures to mitigate surface water runoff would be implemented.)

- The duration of interim storage is for 1 year only.

- The excavated waste volume that accumulates in storage during the 1-year duration is 50 percent of the total projected excavation volume.

- Storage fees are levied by the State of Illinois on Kerr-McGee for the excavated soil in accordance with Public Act 87-1024, the Uranium and Thorium Mill Tailings Control Act, which was passed by the Illinois Legislature and became effective September 6, 1992. This act specifies that "beginning January 1, 1994, an annual fee shall be imposed on the owner or operator of any property [...] being used for the storage or disposal of by-product material, equal to $2 per cubic foot of by-product material." Although the annual fee is levied only once a year, the contingent action cost estimate assumes that 50 percent of the total projected excavation volume is on the Rare Earths Facility in interim storage when the fee is imposed.

- After the year of storage, transportation and disposal become available, at which time the soils are loaded onto trucks and taken to the staging facility at the Rare Earths Facility for transloading and shipment to Envirocare.

4.3.6 Conceptual-Level Description of the Off-Rare Earths Facility Staging Area Contingent Action

To decommission the Rare Earths Facility, Rare Earths Facility wastes will be excavated and transported via the existing EJ&E railroad system to the Envirocare disposal facility. Current plans are to build a railspur in the EJ&E right-of-way (to the east of the existing EJ&E rail line) and then extend the railspur onto the Rare Earths Facility. A staging or loading facility will also be built next to the railspur to facilitate loading railcars for shipment. The loading facility will probably be equipped with front-end loaders, hopper-fed conveyors, and cranes to handle bulk and packaged soils, as well as metal scrap and concrete debris. Kerr-McGee would be the licensee for the transloading operation at the Rare Earths Facility.

The source removal alternative assumes that the excavated soils are transported by truck to the Rare Earths Facility loading facility where it is loaded onto railcars for transport to Envirocare. In the event that the railspur and loading facility at the Rare Earths Facility are unavailable for use (e.g., because of licensing delays, or because Kerr-McGee does not conduct the excavation/restoration work and the work is conducted instead by EPA), the excavated soils can be transported to a different railspur and staging area in or near West Chicago.

For the purposes of this EE/CA, the off-Rare Earths Facility staging area contingent action to the base alternative assumes that the off-Rare Earths Facility railspur and staging area are located an average of 12 miles (one-way) from the site properties; this is approximately 10 miles farther than the assumed 2-mile maximum trip to the Rare Earths Facility from the site properties. A railroad company with presence in West Chicago indicates that multiple potential staging areas exist within the assumed 12-mile radius. The conservative 12-mile radius means that the associated incremental cost estimate for this contingency (Section 5.3) will be an upper limit. The contingent action also assumes that the waste is properly packaged, labeled, manifested, and otherwise ready for shipment when it is unloaded at the staging area. The packaging aspect is important for this contingent action because bulk shipments would require a licensee for the off-Rare Earths Facility staging area that would be responsible for transloading the bulk radioactive material.

4.3.7 Conceptual-Level Description of Recontamination Prevention Contingent Action

The floodplain soils in the residential areas may undergo removal before the current contamination source (Kress Creek site sediment) is removed. If a flood occurs and stream waters rise above the banks, contaminated sediments could be deposited on the cleaned areas. To prevent this, a barrier wall of steel sheet piling may be installed along the banks to an elevation that will protect against a 100-year recurrence flood. The 100-year flood water level at the property line between the residential area and Kress Creek in Zone 2 is at about 6 ft above the ground surface and in Zone 3 is at about 7 ft above the ground surface. The sheet piling will be installed to protect only the residential areas and will tie into high ground both upstream and downstream of these areas to provide an effective flood barrier. The action includes the following criteria:

- The sheet piles should be driven to 9 ft below ground surface and 8 ft above ground surface to allow a minimum of 1 ft of freeboard above the predicted flood elevation.

- Approximately 3,200 ft of sheet piling will be installed in Zone 2 parallel to the banks of the stream, on each side of the stream, throughout the residential area.

- Approximately 2,000 ft of sheet piling will be installed in Zone 3 along the west bank of the West Branch DuPage River.

- The sheet piling should be U. S. Steel PMA 22.

- Twelve-in.-diameter (one-way) check valves will be installed along the sheet piles at appropriate locations to provide stormwater drainage of the residential areas to the stream.

- Some landscaping will be required.

The following assumptions were made for this contingent action; the assumptions are conservative given the fact that flooding frequency, severity, and impacts cannot be predicted with any certainty.

- The residential property excavation/restoration will occur prior to remediation of the creek during the Kress Creek site RA.

- If flooding occurs subsequent to the removal action and before creek remediation, radioactive contaminants would be deposited at the residential property within the floodplain.

- Concentrations of contaminants in deposited sediments would exceed removal action goals.

- Non-residential floodplain areas will not be protected.

Section 5
Evaluation of Alternatives

The candidate removal actions evaluated in this section were introduced in Sections 4.2 and 4.3:

- Alternative 1 – No action
- Alternative 2 – Source removal
- Alternative 2, Contingent Action A – Interim storage
- Alternative 2, Contingent Action B – Off-Rare Earths Facility staging area
- Alternative 2, Contingent Action C – Recontamination Prevention

The three broad criteria (i.e., effectiveness, implementability, and cost) used to screen the response actions in Section 4 are expanded in this section into a more detailed evaluation according to EPA's EE/CA guidance (EPA, 1993b):

- The effectiveness of each alternative (Section 5.1) is evaluated with regard to overall protection of public health; protection of the environment; compliance with regulatory requirements; and the reduction of toxicity, mobility, or volume through treatment.

- The implementability of each alternative (Section 5.2) is evaluated with regard to technical feasibility, administrative feasibility, and availability of services and materials. State and community acceptance are also discussed because of their importance in future evaluations, but are not used as subcriteria for this EE/CA evaluation.

- The cost of each alternative (Section 5.3) is evaluated, as well as the sensitivity of the cost to various cost factors.

5.1 Effectiveness

5.1.1 Protection of Public Health

This subsection addresses whether the alternatives are protective of the health of the public (or community) and workers (during implementation). Assessments of both short-term effectiveness and long-term effectiveness and permanence are included.

5.1.1.1 Alternative 1

Under Alternative 1, no action would be taken for the Residential Areas site and portions of the Kress Creek site until RODs were issued outlining final RA decisions for the sites. For the short term, current exposures to elevated radioactivity levels would remain essentially unchanged for residents. For the long term, exposure could increase in localized areas if below-surface contamination is brought to the surface. Situations in which this could occur include erosion of disturbed soil, property developments or improvements, and utility and street repairs or rebuilding. Localized exposure could also increase in the long term if future houses or other structures are built over areas of elevated radioactivity (hotspots) causing increased gamma and radon/thoron inhalation exposure. In a no-action alternative, activities that could bring contamination to the surface would not be monitored or controlled, and future locations of structures would not be screened for radiological impact during selection.

For the purposes of evaluating the potential health impact of Alternative 1, this EE/CA relies on EPA's conclusions about the current health risks posed on some of the Residential Areas site properties and portions of the Kress Creek site (refer also to Section 2.4.3). As a point of reference, EPA's Superfund program generally considers potential exposure resulting in excess lifetime cancer risks greater than 1 in 10,000 as needing reduction.

For the four residences evaluated in the preliminary focused risk assessment (SC&A et al., 1993), the excess lifetime cancer risk ranged from about 3 in 1,000 to 7 in 10,000. This calculation assumes residents will occupy those homes for 30 years and included contributions to risk from several different exposure pathways. At one of the four residences, the total risk is primarily due to inhalation and ingestion pathways. However, exposure to gamma radiation is the primary contributor to risk at the other residences. Although the risk calculations were conservative and based on minimal data, the results indicate that in the no-action alternative, by omission of any protective response, human health risks are not mitigated.

5.1.1.2 Alternative 2

Under Alternative 2, soils contaminated above EPA's action criteria would be excavated and then transported to an offsite disposal facility. Contaminant toxicity or volume is not affected by the excavation, but contaminant mobility is minimized by relocating the soil to an engineered facility designed for containment. Because contamination would be removed from site properties, radon/thoron decay product levels, gamma radiation levels, and radionuclide soil concentrations would be reduced to near background levels, and potential risks to human health should be correspondingly reduced. Calculations of long-term health risk that would remain after removal will be performed during the RI/FS in a focused residual risk assessment. Data will be collected during the verification phase of the removal to confirm reduction of contamination levels and to support this risk assessment.

Short-term risks may be posed to workers during implementation of Alternative 2. These risks result from temporarily elevated external gamma radiation levels, airborne (resuspended) contamination, and soil radionuclide concentrations potentially occurring during excavation of large volumes of contaminated soil.

An estimate of the radiation dose that could be potentially incurred by workers implementing the source removal alternative was calculated using the RESRAD model (Gilbert et al., 1989). A volume-weighted average concentration of 35 pCi/g for Th-232 and progeny was calculated on the basis of characterization data in the preliminary focused risk assessment (SC&A et al., 1993). During a 1-year period, a maximally exposed worker likely would spend 40 hr per week and 8 months per year in contaminated areas. Pathways considered for the calculation included external gamma exposure and contaminated dust inhalation. Inhalation of outdoor radon or thoron, ingestion of contaminated soil, and dermal exposure were considered negligible for the worker scenario and were not included in this scoping calculation. The estimated maximum annual radiation dose to the worker is 98 mrem/yr. The contribution to the total is 83 mrem/yr from gamma exposure and 15 mrem/yr from dust inhalation. These values are below the regulatory limits of 5,000 mrem/yr for a radiation worker (10 CFR 20).

The above estimate is based on conservative exposure assumptions without recourse to worker protective measures. Actual exposures to workers conducting the removal action are expected to be significantly less than those calculated because of the implementation of safety measures throughout the removal action. These measures include protective clothing, respiratory protection, dust suppression techniques, "on-the-job" and equipment training, as well as instruction to workers about potential safety and health hazards and compliance with applicable state and federal regulations and orders. The potential radiation doses to workers would be kept ALARA. A Health and Safety Plan (HSP) will be instituted that outlines the concepts and methodologies to be followed by the workers.

Short-term risks may also be posed to the general public during implementation of Alternative 2; specifically, a resident living near the property being excavated could potentially receive some incremental dose due to inhalation of airborne contaminants. However, appropriate mitigating measures (e.g., dust suppression) and health physics practices will be employed to minimize the airborne contamination and eliminate the particulate inhalation pathway for the public. An upper limit to the inhalation dose received by a nearby resident is that annual inhalation dose calculated for the worker divided by the fraction of the worker's time (1 year) that an individual resident would be exposed. Assuming an excavation period of 10 days for a single property and therefore a 10-day exposure period for the resident (which is 6 percent of the worker's duration of exposure in a year), the general public would receive a dose of less than 1 mrem. This dose is much less than the dose limit of 100 mrem/yr for the general public and the pathway-specific limit of 10 mrem/yr for airborne releases (40 CFR 61).

Risks to the general public from other exposure pathways are also likely to be negligible: (1) structural interferences (attenuators) and the naturally rapid decrease of dose with distance will limit external gamma radiation exposure, (2) proper security and safeguards at a property being excavated will prevent access to the site and possible direct contact and ingestion of soil contaminants, and (3) the short time frame for material transport minimizes the transient exposures from loaded trucks. In addition, any spillage from the truck should be minimal if packaged or covered properly and, in the event spillage occurs, it could be easily cleaned up and reloaded on the truck. The primary risk from material transport is from vehicular accidents rather than from radiation exposure. A waste transportation plan including routes, spill prevention, and cleanup will be prepared prior to removal implementation.

5.1.1.3 Alternative 2, Contingent Action A – Interim Storage

This contingent action considers 1-year storage of the excavated soil at the Kerr-McGee (Rare Earths Facility) factory site in the event that either transportation or disposal become temporarily unavailable during removal implementation. EPA has performed some calculations (SC&A et al., 1993) to evaluate the additional risk and exposure due to gamma radiation from a Rare Earths Facility storage pile for two hypothetical scenarios: (1) an individual standing at the Rare Earths Facility fenceline closest to the pile (50 to 100 ft away) and (2) a resident living closest to the interim storage pile (approximately 400 ft away). EPA assumed for the calculations an 8,400-yd^3 interim storage pile at the Rare Earths Facility, positioned so that its edge would be approximately 50 ft from the west property line. The 8,400-yd^3 volume is only slightly more than would be expected from Volume Scenario 1 of Alternative 2. Inhalation is not a pathway because the soil is assumed to be packaged or the pile covered during storage. (If it is assumed that waste materials will not be packaged or adequately covered, measures must be taken so that windblown contamination is not released from the Rare Earths Facility. Airborne effluence may be controlled using appropriate dust control methods in conjunction with dust monitoring around the perimeter of the Rare Earths Facility. Sufficient dust controls can keep inhalation from becoming an exposure pathway.)

Current levels of radiation at the factory site near the "calculation-proposed" location of the storage pile are greater than natural background because of the existing contaminated piles that remain from past processing and cleanups. IDNS data show that actual current radiation levels at the closest fenceline west of the proposed location of the storage pile range from 38 to 110 μR/hr. EPA calculated that for a person standing at the fenceline, the interim storage pile would increase that person's level of radiation exposure by 1 to 4 μR/hr, an increase of 2 to 10 percent from current levels.

The increase in exposure rate to the nearest resident (because of the pile) is approximately 0.1 μR/hr (an increase of about 1 percent), which would be hard to distinguish from any existing levels. Based on this hourly rate, EPA estimated that the incremental annual dose would be approximately 0.53 mrem for the 8,400-yd^3 interim storage pile.

The largest soil volume considered for the interim storage contingent action is 60,000 yd^3 (Volume Scenario 4 of Alternative 2). This soil volume in interim storage, a volume 7 times larger than the volume used by EPA for their calculations, would increase annual dose levels (and corresponding health risks) for the nearest resident by a factor of less than 2 to 4 mrem. (The volume/dose relationship is not linear because of self-shielding effects.) Based on these preliminary calculations, the incremental dose levels from the interim storage pile do not cause the regulatory limit of 50 mrem/yr to be exceeded, and the corresponding health risks are much lower for temporary storage than if the contaminated soils are allowed to remain in place at residences.

5.1.1.4 Alternative 2, Contingent Action B—Off-Rare Earths Facility Staging Area

This contingent action considers the option of shipping the excavated soil, in packaged or containerized form, from a railroad spur separate from the one planned at the Rare Earths Facility. No incremental exposures are expected for the worker in this contingent action; incremental exposures to the public should be significantly less than in the interim storage contingency because of the smaller time periods and soil accumulations associated with this off-Rare Earths Facility staging contingency.

5.1.1.5 Alternative 2, Contingent Action C—Recontamination Prevention

Given the conservative assumption that flooding occurs with significant contamination impacts, this contingent action provides dual protection. It protects cleaned residential areas from being recontaminated by flood deposits and provides a barrier between pedestrians and the stream until the stream is remediated. Worker exposure is expected to be less than that incurred during excavation.

5.1.2 Protection of the Environment

This subsection addresses whether the alternatives are protective of air quality, water resources, and the ecology. Assessments of both short-term effectiveness and long-term effectiveness and permanence are included.

5.1.2.1 Air

Under Alternative 1 (No Action), contaminated surface soils will be subject to wind erosion, and subsurface soils will continue to release gaseous radon and thoron. This will impact air quality for the long term. In addition, disturbance of the soil through such actions as property developments or underground utility work increases the opportunity for resuspension and dispersion of contaminants. The dispersion will be temporary and localized, but is an incremental threat to air quality.

Under Alternative 2, the threat to air quality during excavation is similar to that for soil disturbances under Alternative 1 (i.e., the impact is temporary and localized). However, in the Source Removal Alternative, the incremental radiological threat to air quality is recognized and plans are implemented to minimize these threats. During the removal action, various engineering practices and dust suppression techniques could be implemented: (1) concentrations of airborne particulates may be monitored; (2) excavated soil may be packaged (containerized), covered, or wetted on the surface using water sprays; (3) exposed surfaces (without vegetation) could be covered, wetted, and/or backfilled as soon as possible after excavation has occurred; and (4) workers could use respiratory protection as appropriate.

Neither Contingency A or B of Alternative 2 contribute additional threat to air quality if properly packaged and/or covered at the Rare Earths Facility to mitigate wind erosion. Contingency C does not contribute to a threat of air quality.

5.1.2.2 Water

Evidence gathered from investigations at the Rare Earths Facility, Reed-Keppler Park, and Sewage Treatment Plant indicates that leachability of the thorium residuals is relatively small and that no significant groundwater pollution problems are related to the thorium residuals at those sites. However, runoff from these sites may have had impacts in the past on surface water and storm sewer conveyance facilities. Unlike the other Kerr-McGee sites, water resources are not a target of data acquisition for the Residential Areas site and relevant portions of the Kress Creek site because contaminated soil deposits are not as concentrated nor exposed. However, the potential for contamination of surface water may still exist over the long term from contaminant release via runoff from any disturbed, contaminated soil. Under Alternative 1, such potential for contaminant release may continue unabated.

Under Alternative 2, long-term impacts to water resources are negligible, but minor impact over the short term may occur without mitigating measures. This is because the potential for runoff (from water erosion) or leaching increases over the short term due to temporary disturbance of overlying sod and vegetative cover and exposure of the contaminated soils to the elements. Various erosion control measures and practices will be implemented during excavation to mitigate potential releases; these include placing covers over soil piles, installing containment or physical barriers to control runoff, and minimizing delays in backfilling and restoring excavated areas.

Neither Contingency A or B of Alternative 2 contribute additional threat to surface water quality if properly packaged and/or covered at the Rare Earths Facility to mitigate runoff. Contingency C does not contribute to a threat of surface water quality.

5.1.2.3 Ecological

Under Alternative 1, no disturbance or trauma to the terrestrial environment, with its existing habitats and associated biota, would occur. However, as mentioned previously, the potential for (1) exposure to biota and (2) releases to the environment (either through leaching of contaminants or the cyclical resuspension and deposition mechanisms that occur during wind and water transport) would continue.

Under Alternative 2, both excavation and restoration activities could disturb existing habitats and affect the associated biota in the same manner that standard construction activities (e.g., building a house or road) would affect them. The affected habitats would not necessarily have to be located on the properties where the excavation is performed.

Within the project boundaries, land use is predominantly residential. As a result, potential wildlife habitat (terrestrial environment) is limited. Wildlife within these areas is expected to be composed of common edge species with a lower abundance and diversity than less developed lands. Habitat factors within residential areas, such as the maintenance of grassy lawns, abrupt edges, pets, and human disturbances, are expected to limit wildlife presence. These factors are also expected to limit the potential for exposure to wildlife that are present by lessening the possibility for direct exposure to gamma radiation. Direct exposure to some ground-feeding species, as well as the potential for exposure through the food chain, may exist for some wildlife. However, the total number of species potentially affected is considered small. Effects to aquatic environments are being addressed under another site, the Kress Creek site.

Federally designated "critical" habitat for a threatened and endangered species is not known to be present in DuPage County or West Chicago. Other areas that could be considered as sensitive may include state or federal parks and preserves, as well as other important community types such as wetlands. Several state preserves are located in DuPage County (e.g., the Blackwell Forest Preserve, which contains state-listed threatened and endangered species, is located downstream of Kress Creek along the West Branch DuPage River); however, portions of state preserves are located within some of the boundaries of elevated gamma readings for the study area. If individual site properties within the forest preserves are "discovered" according to EPA's action criteria, the forest preserve officials will be contacted and consulted to determine how best to implement the removal while minimizing damage to the environment that may be caused by the implementation. Wetlands are present along Kress Creek and therefore may border residential areas; however, the excavations will not be performed directly in wetlands.

Neither Contingency A or B of Alternative 2 (interim storage at the Rare Earths Facility or off-Rare Earths Facility staging area) contribute additional ecological threat. Contingency C does not contribute significantly to a threat of the ecology. Potentially, some minor disturbance to wetlands and natural drainage within the floodplain may occur in the short term. Long-term effects will be overscored by the stream remediation.

5.1.3 Compliance with ARARs

A description of the ARARs for the Residential Areas site and portions of the Kress Creek site can be found in Appendix B.

Under Alternative 1, because the concentration of radioactive contaminants would remain unaltered, the contaminant-specific ARARs (radon/thoron decay product concentrations, gamma radiation levels, and total radium concentrations in soil) will not be met.

Under Alternative 2, because soil excavation would proceed in accordance with EPA's action criteria and because the action criteria are based on those portions of the regulations judged to be relevant and appropriate, the contaminant-specific ARARs would be satisfied. Alternative 2 complies with all action- and location-specific ARARs, including ALARA. Alternative 2 would also comply during implementation with appropriate Occupational Safety and Health Administration (OSHA) standards, workers safety guidelines, and other federal and state regulations dealing with protection of human health and the environment [e.g., Clean Air Act (CAA), RCRA, Clean Water Act (CWA)].

DOT regulations will govern the packing, handling, labeling, marking, placarding, and routing of material to the transloading and disposal sites. Key definitions that properly guide the selection of DOT regulations for the purposes of this EE/CA are as follows:

- Radioactive material—defined as any material that spontaneously emits ionizing radiation and has a specific activity greater than 2,000 pCi/g

- Low specific activity (LSA) material—defined as uranium or thorium ores and physical or chemical concentrations of those ores

Alternative 2 will comply with the transportation ARAR whether the 11(e)2 waste is classified for transportation purposes as radioactive or LSA material.

With regard to disposal of the 11(e)2 waste, the NRC license held by a commercial disposal facility, such as Envirocare, stipulates those federal ARARs specific to the disposal. The licensed commercial facility accepting the waste will comply with NRC requirements outlined in the license and with host state requirements.

At least two properties on the list of National Register of Historic Places are located within the study area boundary. Whether they will be "discovered" during the site investigation is unknown at this time. If the investigation shows that removal implementation may in some way potentially impact the properties, appropriate mitigating measures will be undertaken.

No unique ARARs compliance issues have been identified for Contingencies A and B.

Contingency C, if implemented, must satisfy a number of location- and action-specific regulations that deal with flow obstruction or alteration of waterways. ARARs dealing with wetlands are also relevant.

5.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

At the present time, no treatment technology has been shown to be more than marginally effective at achieving the desired reduction levels for the types and quantities of soil contamination found at the Residential Areas site. Because some technologies show promise, EPA will continue to monitor and study them for possible future application at the Kerr-McGee sites.

The principal threats at the Residential Areas site are gamma exposure and the generation of radioactive gas and associated decay products indoors, which are subsequently inhaled by the residents of those houses. Because no treatment is available that destroys the radioactive source of these threats, neither alternative satisfies the CERCLA statutory preference for treatment as the principal element.

5.2 Implementation

5.2.1 Technical Feasibility

Technical feasibility does not apply to Alternative 1.

Technical feasibility for Alternative 2, Source Removal, has been demonstrated at other locations around the country. Excavation and restoration use standard construction techniques and good engineering practices to reduce runoff and dispersal. Mature construction techniques exist for excavating in open areas and in confined space conditions in a manner that will protect the structural integrity of buildings. Because the soil contains radioactive contaminants, the excavation techniques are integrated with occupational health physics programs and other safety regimen that are also well established.

Monitoring and sampling after excavation and restoration will determine and confirm the degree to which property has been cleaned up.

Packaging and transport of the waste presents no insurmountable difficulties. Comprehensive soils data have not been collected to accurately predict the range of radionuclide concentrations for the Residential Areas site soils, but based on the limited data available, a reasonable expectation is that the soils content will not exceed the 2,000 pCi/g limit specified for shipment of LSA bulk soils. If the limit is exceeded for some portion of the soils, then based on experience reported at other sites, it is anticipated that blending of soils could be used to lower the concentration. Otherwise, containerization will be necessary, accompanied by the necessary modifications in handling and permitting arrangements for "radioactive material." A rail spur and loading facility will also need to be built at the Rare Earths Facility prior to waste shipment for Alternative 2.

Commercial disposal of 11(e)2 by-product material at Envirocare is technically feasible based on disposal of 11(e)2 waste at other sites and commercial disposal of similarly contaminated soils that are classified as LLW rather than by-product material. Commercial disposal is available at Envirocare (see Section 5.2.2, Administrative Feasibility, for additional comments) with ample capacity for the range of volumes currently predicted. Envirocare is required under their NRC license to adequately contain the waste and provide comprehensive environmental monitoring.

Assembling, staffing, and operating the alternative within the time frames of the removal schedule (see Section 3.3) are feasible given adequate resources for the number of contaminated properties that will be identified during discovery and characterization. The weather may hinder construction work during winter months. All the properties are easily accessible (with regard to terrain and location).

The interim storage contingency (Alternative 2A) is technically feasible based on past storing of excavated materials at the Rare Earths Facility. The off-Rare Earths Facility staging contingency (Alternative 2B) is also technically feasible based on similar actions reported from other U.S. sites with similar soil contamination. The recontamination prevention contingency (Alternative 2C) is technically feasible; the sheets of piling are relatively short and they can be installed with readily available equipment. Disturbance to residential landscaping, fencing, and utilities will be a minor obstacle.

5.2.2 Administrative Feasibility

Under Alternative 1, action would be postponed until a ROD was issued. Administrative feasibility concerns arising from Alternative 1 would include the impact of the delay on perceived health risks, reduced property values and marketability, and potentially restricted land use.

Under Alternative 2, excavation, backfill, and restoration would be conducted in accordance with the terms and conditions of the access agreements to be signed by each property owner. During Kerr-McGee's cleanup action in the mid-1980s, almost all of the property owners cooperated with Kerr-McGee in the cleanup and gave permission for access. Property values and certification of completed surveys and cleanup, as well as other health and environmental advantages, are strong incentives for cooperation of current property owners in this follow-on removal action.

Transportation permits for the short haul via truck to the Rare Earths Facility, and the long haul via rail to the disposal sites should be obtained as required. Approvals for use of a small portion of the Rare Earths Facility as a transloading site for waste shipment would also be needed from the city authorities and other local government and state authorities and from Kerr-McGee. For example, if the excavated wastes are in bulk form rather than in DOT-approved packaging, Kerr-McGee would be required to obtain a license or license amendment from IDNS to receive and stage the wastes at the Rare Earths Facility for shipment.

Commercial disposal of 11(e)2 waste is administratively feasible. Though licensed, Envirocare has not yet received any 11(e)2 waste; however, it is in the process of complying with all the preconditions and stipulated financial obligations of the license. Based on information from Envirocare, the facility will be ready to receive waste from the Rare Earths Facility in September 1994.

Under the interim storage contingency, Kerr-McGee would be required to obtain a license or license amendment from IDNS to receive and store waste from the Residential Areas site and portions of the Kress Creek site (and other Kerr-McGee sites). The license will address any EPA or state issues with regard to definition of roles and responsibilities for participants, waste segregation, monitoring, maximum storage period, and waste management [e.g., packaging or bulk soil covers, National Pollutant Discharge Elimination System (NPDES) permits to monitor runoff (if needed)].

Under the off-Rare Earths Facility staging contingency, no additional permits or administrative requirements have been identified.

The administrative feasibility for the recontamination prevention contingency is impacted by the following regulations:

- Section 10 of the Rivers and Harbors Act of 1899 prohibits the obstruction or alteration of navigable waters of the U.S. without a permit from the U.S. Army Corps of Engineers (USACE). These permits are primarily informational, and stream protection during pile installation will be the primary requirement. A general permit or letter permit may be sufficient because the steel pilings are temporary structures. This procedure could be expected to take 3 to 6 months after design.

- The Rivers, Lakes, and Streams Act; the Federal Water Pollution Control Act of 1972, as amended; and the CWA of 1977 apply when wetlands are disturbed during sheet pile installation, or when the installation affects the flow of the waterway. Compliance with these requirements would be concurrent with the Section 10 USACE permitting process, taking approximately 3 to 6 months after design to complete.

- The Federal Emergency and Management Association (FEMA), Illinois Department of Transportation (IDOT) Department of Water Resources (DWR), and DuPage County all have location- and action-specific requirements. Most applicable are floodplain volume mitigation requirements. These require the design capacity of channels subject to temporary and permanent stream channel impacts to be at least equal to the capacity of the unmodified stream channel immediately upstream and downstream from the diversion. This typically requires flood volume mitigation; when an existing floodway is restricted, additional volume must be provided to mitigate the impact of flooding. The county requirements would typically be the most restrictive, and the federal requirements would be the least. This process would require extensive study and design involving detailed and complex models, and expensive construction of new flood storage volume.

Access agreements with owners of properties where the sheet pilings would be installed would likely be difficult to obtain given the displeasing aesthetics of the sheet pilings and the barrier to the stream that the pilings create.

5.2.3 Availability of Services and Materials

Availability of services and materials does not apply to Alternative 1.

All of the services and materials required to implement Alternative 2 are available. As mentioned, advance planning for scheduling the services and obtaining the materials are critical, especially for scheduling final disposal and for preparing a railroad spur and nearby area for waste transloading. Advance planning will also be needed for obtaining transportation permits and for scheduling work with property owners.

The loading facility and rail spur at the Rare Earths Facility will be servicing transport of Rare Earths Facility wastes during the same time period that soils from the Residential Areas site and portions of the Kress Creek site are to be shipped. Wastes from other Kerr-McGee sites (e.g., Sewage Treatment Plant, Reed-Keppler Park) may also require shipment. Some coordination and even prioritization of wastes from different sites will be necessary to minimize potential for scheduling interferences.

Services and materials are readily available to install sheet piling in a metropolitan area.

5.2.4 State Acceptance

State acceptance refers to the concern and degree of support that the state government may express regarding the proposed removal alternative. The opinions of the State of Illinois cannot be predicted at this time. The state will have opportunity to review and comment on the EE/CA prior to release of the Action Memorandum documenting the final decision.

5.2.5 Community Acceptance

As with state acceptance, community acceptance of an alternative will be considered in the final selection of the alternative. Sections 300.415(m) and 300.820 of the NCP specify two forms of community interaction for all removal actions:

- Community relations activities that are designed to integrate the information needs of the community into the Community Relations Plan (CRP) for the site.

- Administrative record activities that are designed to chronicle the basis for the response action and serve as a vehicle for public participation in the removal action. This EE/CA will be part of the public record.

These forms of community interaction will help ensure that the proposed action satisfies local or community concerns. The community will have opportunity to review and comment on the EE/CA prior to the release of the Action Memorandum.

5.3 Estimated Cost

Cost estimates are presented here to allow a comparison of alternatives based on relative cost. The cost estimates are intended to provide an accuracy between +50 and -30 percent for the scope of work described. EPA guidance allows the use of Order of Magnitude estimation for the purposes of assessing the relative expense of a given alternative as compared with any other option or with a base option. At this stage, detailed costs such as those based on a completed design are not expected to be available.

Cost estimates generally include the following:

- Direct capital costs (e.g., construction, equipment and material, relocation, transport and disposal, laboratory analysis, insurance, contingency)

- Indirect capital costs (e.g, engineering, legal services and administration, licensing and permitting)

- Post-removal site control (PRSC) costs (e.g., operation and maintenance, auxiliary materials and energy, monitoring, support)

Direct and indirect costs are included in this EE/CA, but PRSC costs are excluded because (1) the nature of the source removal alternative is such that it is generally not a repetitive action (i.e., with very few exceptions, additional post-verification work on a particular property are not expected to be necessary), (2) if a second cleanup is required, as might be required for portions of the Kress Creek site (e.g., if flooding occurs), costs for the second cleanup are incurred under the RA and not the removal action, and (3) the RI/FS and ROD will immediately follow the completion of the removal action thereby negating the necessity of the CERCLA-required 5-year cyclical reevaluation of any interim action. In addition, present worth is not considered for the two alternatives in this EE/CA. Although the project duration will exceed 12 months, the proposed aggressive schedule for the removal is less than 24 months. Thus, present worth considerations would not appreciably impact alternatives comparison.

Under Alternative 1, no removal actions would be implemented; therefore, the estimated cost would be zero.

For Alternative 2, Source Removal, total estimated costs are presented in Table 5-1 and Figure 5-1. Additional detail is provided in Appendix C. The basis and primary assumptions for the cost estimates are itemized below.

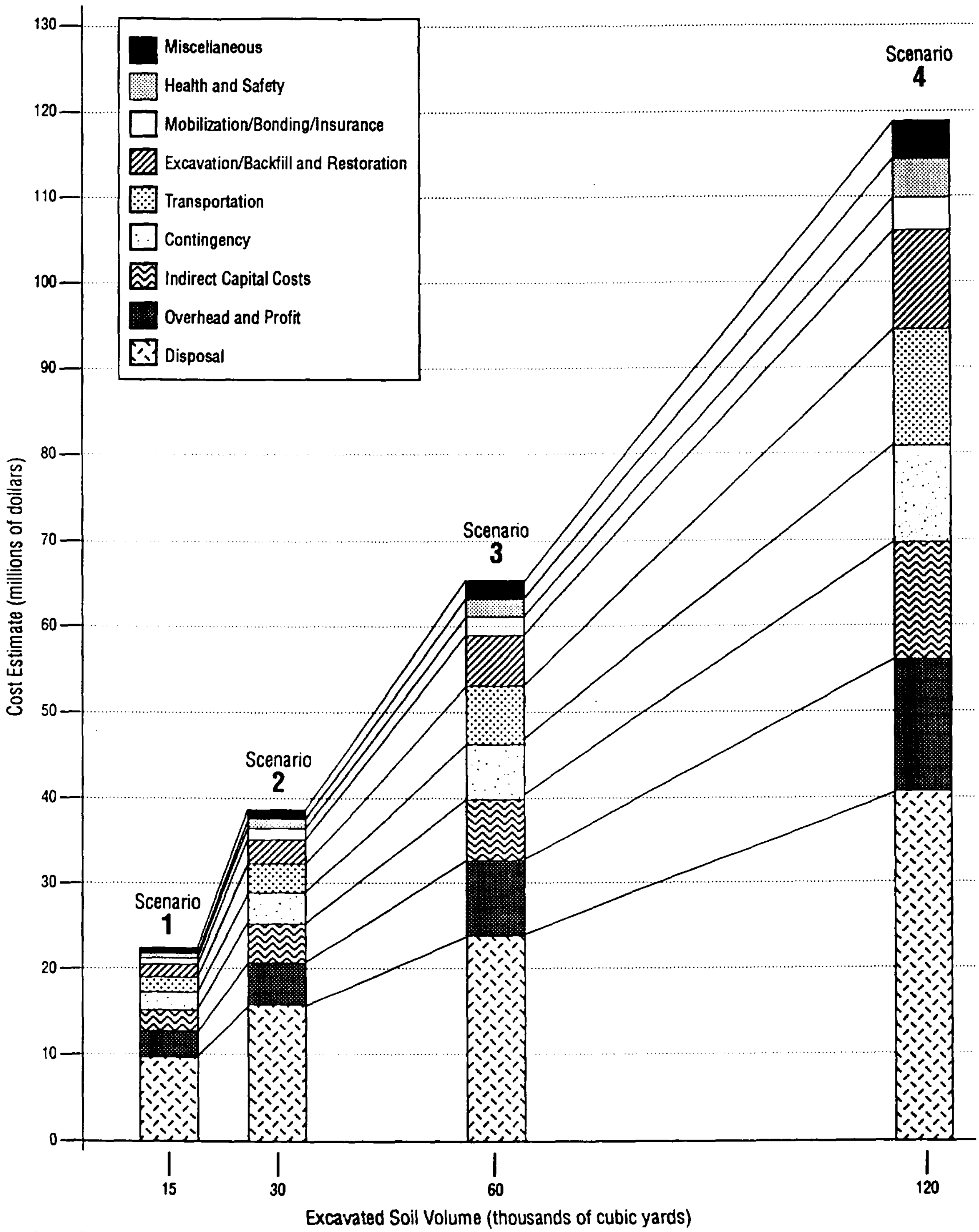
- Estimates of the excavated soil volume and the corresponding number of affected properties are based on the range discussed in Table 4-1.

Table 5-1
Cost Estimates for Alternative 2, Source Removal

Item	Soil Volume Scenario 1[a]	Soil Volume Scenario 2[a]	Soil Volume Scenario 3[a]	Soil Volume Scenario 4[a]
Volume (yd^3)	15,000	30,000	60,000	120,000
Number of Properties	50	100	200	400
Direct Capital Cost Items				
Health and Safety	$615,200	$1,161,900	$2,264,500	$4,478,900
Transportation	1,708,500	3,417,000	6,834,000	13,668,000
Excavation, Backfill, and Restoration	1,445,500	2,891,000	5,782,000	11,564,000
Disposal	9,750,000	15,750,000	24,000,000	40,500,000
Miscellaneous[b]	589,005	1,142,010	2,248,020	4,460,040
Subtotal Direct Capital Cost	**$14,108,205**	**$24,361,910**	**$41,128,520**	**$74,670,940**
Overhead and Profit	$2,927,453	$5,055,096	$8,534,168	$15,494,220
MOB[c]/Bond/Insurance (5% of subtotal)	705,410	1,218,096	2,056,426	3,733,547
Contingency (15% of subtotal)	2,116,231	3,654,287	6,169,278	11,200,641
Total Direct Capital Cost (rounded off)	**$19,857,000**	**$34,289,000**	**$57,888,000**	**$105,099,000**
Indirect Capital Cost Items				
Engineering and Design (8% of total)	$1,588,560	$2,743,120	$4,631,040	$8,407,920
Legal and Administrative (3% of total)	595,710	1,028,670	1,736,640	3,152,970
Licensing and Permitting (2% of total)	397,140	685,780	1,157,760	2,101,980
Subtotal Indirect Capital Cost	**$2,581,410**	**$4,457,570**	**$7,525,440**	**$13,662,870**
Grand Total (rounded off)	**$22,400,000**	**$38,700,000**	**$65,400,000**	**$118,800,000**

[a]Basis for volume scenarios is discussed in Table 4-2.
[b]Miscellaneous costs include loading, packaging, and sampling the waste material; verification sampling; and temporary family relocation.
[c]MOB = Mobilization.

Note: Costs are order of magnitude estimates with an expected accuracy of +50 to -30 percent. Detail for direct capital costs is in Appendix C. The order of magnitude costs have been prepared for the purpose of assessing the relative expense of a given alternative as compared with any other alternative and should not be considered as final estimates for negotiation. They are based on information available at the time of the estimate, information gathered from suppliers, and, to a large extent, on the experience and judgment of the study team. The final costs of the project will depend on actual labor and material costs, actual site conditions, final project scope, implementation schedule, and other variable factors.



NOTES:

1 Costs are order of magnitude estimates with an expected accuracy of +50 to -30 percent.

2 This figure is based on Table 5-1 data. Detail for direct capital costs is in Appendix C.

Figure 5-1
Cost Estimates for Alternative 2, Source Removal
Residential Areas Site and Portions of the Kress Creek Site

- Cost accrual begins after the properties have been discovered and characterized (i.e., work to perform discovery and characterization is not reflected in the cost estimates).

- Health and safety costs are based on a lump-sum amount that includes costs for planning, training, monitoring, Personal Protective Equipment (PPE), decontamination stations, and equipment rental.

- Transportation costs include the costs for hauling the contaminated material by truck from the property to the rail spur and loading facility at the Rare Earths Facility, and then transporting by rail to the disposal site.

- Excavation, backfill, and restoration costs include the costs for removing the contaminated soils, backfilling with clean fill material, and restoring the property to its original condition.

- Kerr-McGee currently has a contract with Envirocare of Utah for the disposal of the wastes from this site. Contracted disposal fees are considered privileged information; however, for the purposes of this EE/CA, the cost estimate assumes that the base disposal fee is $650/yd^3 for volumes up to 20,000 yd^3 and $275/yd^3 for volumes above 20,000 yd^3.

- Construction of Rare Earths Facility staging facilities such as the rail spur, loading facility, and decontamination pad are considered part of Rare Earths Facility decommissioning and are not reflected in the EE/CA cost estimate.

- Miscellaneous costs include loading, packaging, and sampling the waste by-product prior to shipment. Also included is the cost of temporary family relocations (10 percent of the properties only) and verification sampling.

- Add-on direct capital costs include overhead, profit, contingency, mobilization, bonding, and insurance.

- Add-on indirect capital costs include engineering and design, legal and administrative requirements, and licensing and permitting.

The total cost of Scenario 1 is $22,400,000 and is based on 50 property sites (15,000 yd^3) for a total of $448,000 per property ($1,490/yd^3). The total cost of Scenario 2 is $38,700,000 and is based on 100 property sites (30,000 yd^3) for a total of $387,000 per property ($1,290/yd^3). The total cost of Scenario 3 is $65,400,000 and is based on 200 property sites (60,000 yd^3) for a total of $327,000 per property ($1,090/yd^3). The total cost of Scenario 4 is $118,800,000 and is based on 400 property sites (120,000 yd^3) for a total of $297,000 per property ($990/yd^3). Disposal costs account for 34 to 44 percent of the total estimated costs, transportation costs account for 8 to 12 percent of the total, health and safety costs account for 3 to 4 percent of the total, and excavation/ backfill/restoration costs account for 6 to 10 percent of the total costs. Contingency costs account for 9 percent of the total, overhead/profit costs account for 13 percent of the total, and mobilization/insurance/bonding costs account for 3 percent of the total costs. Indirect capital cost items account for approximately 12 percent of the total estimated costs.

It is expected that most of the site contamination is limited to shallow depths (e.g., no more than 2 ft) and to areas around, rather than underneath, structures. Therefore, the above cost estimates include source removal to shallow depths in both open and confined areas (e.g., next to a structural foundation). However, because the comprehensive site investigation has not yet been performed, it is unknown whether and to what extent contamination may exist under structures necessitating more arduous and expensive source removal tasks. The above cost estimates (e.g., Table 5-1) do not include major cost items resulting from source removal under structures. A sensitivity analysis has been performed on the cost estimates to determine the impact of those additional, but probably infrequent, major cost items resulting from locating significant contamination deposits under structures.

For the purposes of the sensitivity analysis, it is assumed that 10 percent of the "discovered" properties in each scenario would have major cost items performed at the same time as the basic removal action. These major cost items include basement slab removal and replacement, replacement of home mechanical systems, deep excavation that requires shoring and underpinning of the structure, garage removal and replacement, moving of a house, and installation of engineering controls for radon/thoron reduction. The radon/thoron reduction would be an allowed cost only for those properties where (1) the radon/thoron originated from Rare Earths Facility-produced materials and not from naturally occurring situations, (2) excavation was delayed and could not occur in a timely fashion, (3) excavation was not cost-effective or appropriate, and (4) owner permission to excavate under a structure could not be obtained. These major cost items, detailed in Appendix C, are estimated to increase the total costs in each scenario by 5 to 7 percent.

Table 5-2a gives estimates of the incremental total capital costs to implement Contingent Actions A and B of Alternative 2. For Contingent Action A, interim storage at the Rare Earths Facility, the incremental cost estimates are $577,000; $1,150,000; $2,310,000; and $4,620,000 for Scenarios 1 through 4, respectively. These costs represent increases over the Alternative 2 base cost estimates of 3 to 4 percent. Included in the costs are the annual state tax for 11(e)2 waste, the additional work of unloading and stockpiling the filled bags of soil at the Rare Earths Facility, and when the waste can be shipped, loading the waste onto a flatbed truck for transport to the loading facility and rail spur. For Contingent Action B, off-Rare Earths Facility staging area, the incremental cost estimates are $179,000; $357,000; $714,000; and $1,430,000 for Scenarios 1 through 4, respectively. These costs represent increases over the Alternative 2 base cost estimates of 0.8 to 1.2 percent. The incremental cost covers the additional mileage to haul the packaged soil to a rail spur elsewhere in the West Chicago area.

Table 5.2b gives estimates of the incremental capital costs to implement Contingent Action C of Alternative 2. For Contingent Action C, Recontamination Prevention, the incremental costs are $928,000 for Zone 2 and $616,000 for Zone 3, for a total of

Table 5-2a Estimates of Incremental Costs[a] for Alternative 2 Contingent Actions A and B				
Item	**Soil Volume Scenario 1[b]**	**Soil Volume Scenario 2[b]**	**Soil Volume Scenario 3[b]**	**Soil Volume Scenario 4[b]**
Volume (yd^3)	15,000	30,000	60,000	120,000
Number of Properties	50	100	200	400
Contingent Action A:				
Interim Storage (rounded off)	$577,000	$1,150,000	$2,310,000	$4,620,000
Contingent Action B:				
Off-Rare Earths Facility Staging Area (rounded off)	$179,000	$357,000	$714,000	$1,430,000

[a]Costs include direct capital add-ons of approximately 40 percent to cover overhead, profit, mobilization, bonding, insurance, and contingency. Direct capital cost detail is provided in Appendix C. The costs also include indirect capital add-ons of 13 percent of the total direct capital cost to account for engineering and design, legal and administrative needs, and licensing and permitting requirements.
[b]Basis for volume scenarios is discussed in Table 4-2.

Note: These estimates are order of magnitude estimates with an expected accuracy of +50 to -30 percent. The order of magnitude costs have been prepared for the purpose of assessing the relative expense of a given alternative as compared with any other alternative, and should not be considered as final estimates for negotiation.

Table 5-2b Estimates of Incremental Cost[a] for Alternative 2 Contingent Action C		
Item	**Zone 2 Protection**	**Zone 3 Protection**
Subtotal Direct Capital Cost	595,872	395,540
Total Direct Capital Cost (includes add-ons of overhead and profit, MOB/bond/insurance, and contingency)	821,000	545,000
Indirect Capital Cost (13%) (includes add-ons of engineering and design, legal and administrative, and licensing and permitting)	106,730	70,850
Grand Total (rounded off)	928,000	616,000

[a]Not included are any incremental costs for floodplain volume mitigation; additional design and investigation would be required to determine the mitigation requirements and to quantify these costs.

Note: These estimates are order of magnitude estimates with an expected accuracy of +50 to -30 percent. The order of magnitude costs have been prepared for the purpose of assessing the relative expense of a given alternative as compared with any other alternative, and should not be considered as final estimates for negotiation.

$1,544,000. This cost represents an increase over the Alternative 2 base cost of 1 to 7 percent. It is valuable to compare the above cost for the sheet pilings, which would prevent recontamination of the floodplain, with the cost of repeating the cleanup of the floodplain in the event that a flood recontaminated it. This repeat cleanup for the floodplain would occur concurrently with the Kress Creek site remediation. The floodplains of interest are those portions of the Kress Creek site that extend from the streambank to the 100-year flood contour and that lie in the residential areas in Zones 2 and 3 (see Figure 1-2). The area of these floodplains is approximately 376,000 ft^2. Assuming conservatively that *all* of this area becomes recontaminated by a flood to levels *greater* than EPA's action criteria, and assuming that an excavation depth of 2-1/2 to 3 in. is sufficient to remove the thin layer of contamination deposited by the flood, the expected maximum volume of excavated soil would be approximately 4,000 yd^3. Multiplying this volume by the unit cost of approximately \$1,000/yd^3 (rounded off) presented earlier for Alternative 2 gives a total repeat cleanup cost for the floodplain soils of \$4 million. This *upper limit* cost is less than 3 times greater than the \$1.5 million (rounded off) for the sheet pilings.

5.4 Comparative Analysis for Alternatives

The purpose of the comparative analysis is to identify the relative advantages and disadvantages of each alternative so that key tradeoffs that would affect the remedy selection can be identified. Table 5-3 summarizes the comparison for the two base alternatives for the Kerr-McGee Residential Areas site and portions of the Kress Creek site. The summary table outlines important conclusions regarding effectiveness, implementation, and cost. Table 5-4 highlights key issues with regard to the contingent actions.

5.5 Preferred Alternative

The preferred action is Alternative 2, Source Removal, for both the Residential Areas site and for portions of the Kress Creek site. The preferred action includes the following components:

- Remove contaminated materials above removal action levels from the site properties to minimize potential hazards to human health and the environment associated with the contamination.

- Provide interim measures (e.g., indoor engineering controls) for those limited and exceptional situations where excavation is delayed or inappropriate to reduce the risks attributable to the contaminated material.

- Limit the potential health hazards to onsite workers performing the removal action.

Table 5-3
Comparative Analysis of Removal Action Alternatives
Residential Areas Site and Portions of the Kress Creek Site

Criteria	Alternative 1 – No Action	Alternative 2 – Source Removal
Effectiveness	No protection provided; no immediate change in human health and environmental impacts.	Short-term impacts on human health and the environment during the removal can be mitigated.
	Exposure could potentially increase in localized areas if below-surface contamination is inadvertently disturbed.	Protective of public health and the environment over the long term for the Residential Areas site; additional (post-removal) remediation of the properties will likely not be necessary. Overall effectiveness of removal action for portions of the Kress Creek site is dependent on the probability of recontamination.
	Does not comply with ARARs.	Complies with ARARs.
	No reduction in toxicity, mobility, or volume.	No reduction in toxicity, mobility, or volume, but waste is contained at disposal facility.
Implementability	Technical feasibility not applicable.	Alternative is technically feasible since excavation, restoration, transportation, disposal, and health physics aspects use standard techniques and readily available equipment.
	Alternative is administratively infeasible given state and local concerns about perceived and actual risks, reduced property values, marketability, and potentially restricted land use.	Alternative is administratively feasible, but advance planning is critical for EPA's aggressive schedule. Time will be needed to obtain agreements with property owners, obtain permits from state and local authorities, and provide for a waste transloading facility and rail shipment. A license amendment may be needed for Kerr-McGee to receive material at the Rare Earths Facility from the Superfund sites.
	Availability of services and materials not applicable.	All services and materials needed for implementation are obtainable.
Cost	Zero cost.	Total costs are estimated as follows: - \$22 million for 15,000 yd^3 (50 properties) - \$39 million for 30,000 yd^3 (100 properties) - \$65 million for 60,000 yd^3 (200 properties) - \$119 million for 120,000 yd^3 (400 properties) Costs will increase in rough proportion to the number of properties with contamination found under structural foundations.

Table 5-4
Key Issues Analyses of Alternative 2 Contingent Actions

Criteria	Contingent Actions: A: Interim Storage	B: Off-Rare Earths Facility Staging Area	C: Recontamination Prevention
Effectiveness[a]	Action decreases exposure at the properties by not delaying removal. Incremental increases of exposure around the Rare Earths Facility do not cause the regulatory limit to be exceeded.	Action decreases exposure at the residences by not delaying removal. No incremental exposures are expected for the worker. Incremental exposures to the public at the staging area are slight.	Action provides a temporary access barrier to contaminated stream sediments and a flood barrier to prevent recontamination for cleaned-up floodplain soils. The measure disturbs wetlands and natural drainage within the floodplain.
	Complies with ARARs.	Complies with ARARs.	Complies with ARARs.
Implementability	Technically feasible.	Staging areas are available.	Installation can be performed with readily available equipment.
	A license amendment for storage is required from IDNS.	Administratively feasible.	Regulatory requirements are exacting and may delay installation. The barrier impacts aesthetics of and access to the stream.
	All services and materials needed for implementation are obtainable.	All services and materials needed for implementation are obtainable.	All services and materials needed for implementation are obtainable.
Cost[b]	3 to 4%	0.8 to 1.2%	1 to 7%[c]

[a]The contingent actions are all temporary responses, and so some of the effectiveness criteria, such as long-term protectiveness of public health and the environment, as well as reduction of toxicity, mobility, or volume through treatment, do not apply.
[b]The costs are incremental costs above the base cost of Alternative 2, shown as percentages of the base cost.
[c]The incremental cost does not include potential flood volume mitigation expenses.

- Restore those site properties where removals occurred according to agreements established with each property owner.

- Using appropriate environmental monitoring during and after removal, verify the remedy's effectiveness for each affected property (i.e., verify that the removal action successfully minimized potential hazards to human health and the environment).

- Ultimately dispose of the removed soils in a timely fashion at a licensed offsite facility. The Rare Earths Facility may be used as a staging or transloading area for waste shipment to the disposal facility given that a railspur and loading facility will be built at the Rare Earths Facility as part of Rare Earths Facility closure.

Alternative 2 best satisfies the removal action objectives and the evaluation criteria of effectiveness, implementability, and cost. Two of the contingent actions for Alternative 2, interim storage and off-Rare Earths Facility staging, are also allowed in the event that temporary impediments to transport or disposal occur.

Once implemented, and assuming regulatory bodies do not change the contaminant-specific ARARs after removals have been completed, the source removal alternative is effective and long-term (i.e., the solution for the Residential Areas site is permanent, and dispersal of contaminated soil could not occur in future property development or community infrastructure improvements). Over the long term, the source removal alternative protects human health and the environment. Short-term impacts to health and the environment due to soil disturbance during the removal can be mitigated with good engineering practices and appropriate health and safety measures. This alternative also complies with ARARs and EPA's action criteria, strong incentives to initiate the removal action in a timely fashion.

The implementability of Alternative 2, as well as Contingent Actions A and B, has been demonstrated at other locations around the country. Excavation and restoration use standard construction techniques and good engineering practices to reduce runoff and dispersal. Mature techniques also exist for packaging, transport, and disposal of the wastes. Because the soil contains radioactive contaminants, the removal action techniques are integrated with occupational health physics programs and other safety regimens that also are well established. Services and materials are also available or can be obtained without undue difficulty. However, some major project requirements will need to be carefully considered in planning to prevent them from later becoming major obstacles to implementation; examples include establishing a railroad spur and transloading site for transferring the waste from trucks to rail cars and obtaining the necessary permits (e.g., construction, interstate transport) from local and state authorities and agreements with property owners.

The volumes of contaminated soil to be excavated from the Residential Areas site and portions of the Kress Creek site are unknown. Therefore, a range of excavation volumes and associated total costs were presented for Alternative 2. This alternative is cost effective because it provides the highest degree of overall effectiveness (protection of public health and the environment) relative to its range of costs. Opportunities for the removal action contractor to improve the cost efficiency for this alternative will occur as the work progresses through value engineering and application of lessons learned.

The source removal option is preferred for the relevant portions of the Kress Creek site for many of the same reasons it is preferred for the Residential Areas site (see Table 5-3). One advantage of cleaning up both floodplain and non-floodplain soils in a residential area is that it provides complete rather than partial protection of human health (i.e., a significant portion of a property does not remain contaminated). Other advantages are that concurrent rather than separate source removals on a property are more efficient (logistically and economically) and reduce disruption for the property owner. A potential disadvantage would arise if the cleaned-up floodplain soils became recontaminated as a result of flooding. In this situation, the long-term protectiveness afforded by the initial cleanup decreases in proportion to the extent and level of recontamination, and costs for a second cleanup may be incurred when the Kress Creek site is remediated.

Contingent Action C, Recontamination Prevention, is a temporary option evaluated in this EE/CA for minimizing flood impact on floodplain soils in residential areas that have undergone a removal action. This contingent action is protective of human health because it prevents recontamination of residential properties that lie in the floodplain, and it limits access to contaminated stream sediments. The contingency is also technically feasible and can be implemented with available services and materials. The contingency was shown earlier to be less expensive than cleaning up the floodplain's soils a second time for a hypothetical situation where a significant fraction of the floodplains was recontaminated to levels above the action criteria. Nevertheless, full cost effectiveness can only be demonstrated under the assumption that the probability is high that (1) a severe flood will occur prior to the Kress Creek site remediation and (2) the flood will recontaminate a significant fraction of the floodplain to levels above the action criteria. However, the contingency is disallowed because the administrative hurdles and construction schedule will likely delay significantly the initial cleanup of portions of the Kress Creek site. In addition, it is anticipated that the sheet pilings will generate community concerns because of the impact of the barrier on the stream aesthetics and access.

The preference then for source removal for portions of the Kress Creek site is a (non-quantified) risk management preference that assumes that floods causing significant recontamination (such as a 100-year flood) will not occur prior to the Kress Creek site remediation (anticipated to occur in 2 to 3 years). Initial cleanup of portions of the Kress Creek site will proceed in parallel with Residential Areas site efforts. If flooding recontaminates the cleaned-up portions of the Kress Creek site, a second cleanup effort will occur during the Kress Creek site RA.

Section 6
Applications of ALARA

As low as reasonably achievable (ALARA) is a phrase (acronym) used to describe an approach to radiation protection to manage exposures and releases of radioactivity to the environment to levels as low as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit, but an approach or philosophy with a goal to attain dose levels as far below regulatory limits as reasonably achievable.

The action criteria document (Appendix A) for removal actions at the Kerr-McGee Residential Areas site and portions of the Kress Creek site established a criteria for assuring that cleanups are conducted to levels that are ALARA. The criteria document further states that "every reasonable effort should be made to maintain radiation exposures, and the amount of radioactive materials in unrestricted areas, to levels that are ALARA." The precedent and basis for using ALARA is well established; the approach is integrated into 10 CFR 20 (*Standards for Protection Against Radiation*), Department of Energy (DOE) Order 5400.5 (*Radiation Protection of the Public and the Environment*), the NRC's Regulatory Guide 8.37, and Section 340.1000(b) of the Illinois Administrative Code. Each of the aforementioned promulgated regulations or guidances have been identified by EPA as TBC material for the Residential Areas site and portions of the Kress Creek site removal action.

ALARA considerations generally involve activities affecting environmental protection, worker protection, and waste management and transport. EPA action criteria and cleanup guidelines are used to identify the activities and precautions involved in cleanup operations. Technical and economic considerations include engineering controls, waste volumes, and waste removal options. Conservative operating methods and controls are selected so that dose levels resulting from residual contamination after cleanup are commensurate with the goals of ALARA.

The ALARA approach is integrated into the Residential Areas site and portions of the Kress Creek site removal action. Evaluations have been qualitative in nature; no cost-benefit analyses have been performed. Reasonable efforts will be made to maintain radiation exposures and the amount of radioactive materials in unrestricted areas to levels that are ALARA.

The following ALARA topics are discussed in this section:

- Administrative requirements (Section 6.1)
- Worker protection (Section 6.2)
- Protection of the general public and the environment (Section 6.3)
- Waste management and transportation (Section 6.4)

6.1 Administration of ALARA

6.1.1 Reporting of Regulatory Compliance Violations

ALARA planning should provide a system for reporting to appropriate agencies when hazardous material exposure limits, both radiological and nonradiological, are exceeded. For the Residential Areas site and portions of the Kress Creek site, the primary compliance concern is meeting the removal criteria of 5 pCi/g total radium above background. For those situations, if any, where this criteria may be exceeded as a result of extraordinary costs or impacts associated with meeting the criteria, a hazards analysis will be conducted and documented in a memorandum to EPA.

Other potential exceedances of regulatory criteria (personnel radiation exposures, releases of contaminated dusts, etc.) will also be handled through notification of EPA. Notification of other regulatory (state or federal) authorities will be made by EPA.

6.1.2 Documenting ALARA

Specific documentation methods for recording implementation of the ALARA process are not provided. Because ALARA is a major factor in each facet of site actions, its specific documentation would involve considerable redundancy. Each removal and RA requires the generation of specific documents. ALARA considerations are incorporated within these documents. Example documents include those that report investigative findings (RI/FS and EE/CA reports), define potential risks (residual risk assessment), identify engineering approaches (design documents), compare alternative costs (FS and EE/CA reports), identify planned work (work plan), direct RAs (procedures), control project safety (project HSP), and record operational efforts (permits and audits).

Summary (RI/FS and EE/CA) reports and risk assessments document the technical findings and evaluate this information as it pertains to potential hazards and liabilities. While these documents are primarily intended to identify and evaluate site conditions, they are valuable in highlighting potential hazardous conditions that may be factored into remedial planning and implementation of the ALARA process. Design documents and project work plans identify the tasks to be performed and, to some degree, the methods by which work efforts are to be performed. Again, the ALARA process must be factored into this planning for the safety of workers and the general public. The work instructions, procedures, permits, and HSP instruct workers on how to perform each task and incorporate concerns for hazardous conditions. ALARA concerns are included in the development of these documents so that hazards are dealt with on a routine basis. The various assay reports (dosimetry and bioassay reports) document exposures encountered and permits evaluation of ALARA controls. Internal audits are performed that permit evaluation of the ALARA process and provide an opportunity to incorporate improved safety approaches [Bechtel National, Inc. (BNI), 1992].

6.1.3 ALARA Decisionmaking Process

Evaluations of the ALARA approach for a particular process may be either quantitative or qualitative. In addition, the ALARA evaluations may be used to justify action below EPA limits.

A wide range of approaches and tools are permitted for meeting ALARA goals. These tools range from cost-benefit formal analyses to more rudimentary analyses based on fundamental understanding and commitment to the ALARA process. In many cases, common sense and sound judgment in making decisions—rather than formal quantitative techniques—may be all that is required (DOE Order 5400.5). Regardless of the techniques employed in making an ALARA decision, the specific factors that should be considered include the following:

- Maximum dose to any member of the public
- Collective effective dose commitment to the nearby population
- Alternative processes (e.g., treatments, methods, or controls)
- Individual and collective doses for each process alternative
- Costs associated with each process alternative
- Differences in costs and impacts among process alternatives
- Anticipated changes in doses to workers
- Nonradiological impacts

Additionally, it is important that the level of effort, the significance of support information, and the magnitude of documentation be commensurate with the magnitude of the potential doses and costs. For instance, an activity resulting in low personnel exposures is more likely to be implemented based on a judgmental decision. However, an activity involving significant personnel exposures or environmental insult potential would require in-depth study in the decisionmaking process.

In most instances, the amounts of radioactive contaminants at the Residential Areas site and portions of the Kress Creek site are relatively small, and the support efforts for ALARA decisions are rudimentary. In these instances, the associated analyses are not rigorous, the differences in doses and cost are generally small, and a detailed ALARA review is not warranted.

In the few instances where the amounts of radioactive contaminants may be relatively large, a more rigorous analysis is involved in the ALARA decision process. These instances require a cost-benefit study of site-specific environmental and population risks for various radiation exposure scenarios. This study would involve a broad range of social, public policy, demographic, and practical considerations. However, the parameters needed to evaluate the cost-benefit analyses are often difficult to quantify and the evaluations can be expensive. Furthermore, the evaluations may include many additional assumptions, judgments, and limitations that are of themselves difficult to substantiate. Modeling and use of assumptions, particularly for the nonqualified factors, would be necessary for conducting a rigorous analysis (BNI, 1992).

Special situations, which are as yet unidentified, may arise during the course of the removal action that are unusually difficult and cost-prohibitive to clean up the action criteria. DOE Order 5400.5, considered to be a TBC for the Residential Areas site and portions of the Kress Creek site, states that if special specific property circumstances indicate that the authorized limits are not appropriate for any portion of that property, then supplemental limits or an exception may be applied. The decision must be justified and documented that the authorized limits are not appropriate and that the alternative action selected will provide adequate protection. Such situations, if any, will be judged on a case-by-case basis.

6.2 Worker Protection

ALARA is implemented in worker training and in daily operations for worker protection.

6.2.1 Worker Training and Preparation

Preplanning of field operations identifies the efforts to be performed and the ALARA considerations that must be integrated into the operations. From this effort, personnel with appropriate technical capabilities are assigned to support each project function, and a staff of qualified workers is obtained. In most instances, specific training of a site staff is required to prepare for specific work efforts and to acquaint the workers with ALARA considerations. This training is documented on a form that lists the title or subject of training, the trainer, the date, and the employee's signature. The form is placed in the employee's personnel file as a permanent record. Once work begins, meetings are held at the work site as necessary. During these meetings, specific health and safety concerns are discussed and training is performed.

This training is provided in three different categories depending on the duties of the workers. These categories are discussed below.

- **OSHA (Occupational Safety and Health Administration) Training.** This training includes 40 hr of safety information prescribed by OSHA, followed by 8 hr of annual refresher training. This training prepares workers to respond to any hazardous situation that may be encountered. The requirements for the performance of this training will be monitored by the Site Safety Coordinator (SSC).

- **Indoctrination in Relevant Project Instructions and Plans.** This training is provided to each worker to develop a consistent and effective approach to project tasks. This training includes orientation and quality assurance (QA) indoctrination for all project staff, as well as a review of relevant project instructions and procedures. Each individual will be required to read the HSP. The site manager is responsible for determining the required instructions and procedures for each worker and to maintain the quality of project work.

- **Site Briefing**. Each individual will attend a site briefing given by the SSC or equivalent. The purpose of the site briefing is to provide orientation to and additional knowledge of project work. All individuals working or frequenting any portion of a radiation area shall be informed of the occurrence of radioactive materials or radiation in the area. They shall be educated on safety problems associated with exposure to such materials or radiation and on the precautions and devices to minimize exposure.

6.2.2 Field Implementation

When feasible and practicable, the use of administrative and engineering controls is preferred over the use of protective equipment to minimize exposure to hazardous materials. Work plans and subcontractors' specifications identify the controls and specify the actions needed to reduce potential exposure levels to permissible limits. When these measures are found to be inadequate, worker protection is accomplished by using specific equipment. This equipment includes, but is not limited to, protective body clothing (coveralls), gloves, boots, headgear, and respiratory protective devices and the proper use of shielding, distance, and mockup training if justified. Standard posting protocols, dosimetry programs, and decontamination procedures are also implemented. Worker protection may also include monitoring ambient air before workers enter a work area. A health physicist is available to assess the level of protection necessary to meet the ALARA objectives.

The SSC is responsible for assessing the potential dangers for daily activities that occur in radiation areas. Before work begins, the SSC assesses the area and determines specific ALARA practices (if applicable) for each job task. If this assessment indicates a significant potential hazard, appropriate radiation protection procedures are instituted.

Calculations that are required for the determination of proper ALARA practices are checked, reviewed, and approved by the project health physicist or designee and are then recorded in the health and safety project files.

6.3 Protection of the General Public and the Environment

To protect the general public and the environment, EPA has established action criteria (Table 3-1 and Appendix A). The principal action criterion is that the outdoor soil concentration should not exceed 5 pCi/g radium above background. This is the maximum concentration that is allowed to remain. In addition, EPA is committed to an aggressive ALARA program during the removal action, which will generally include removal of contaminated soils as far below target cleanup criteria as reasonably achievable (e.g., in situations where implementation costs are reasonable and incremental risks to removal action personnel are low). This ALARA concept could be restated as follows:

> *Limit the maximum (total radium) residual concentration at individual locations to 5 pCi/g above background, while striving to reduce to levels nearer background the residual concentration at the greatest number of locations possible.*

The basic objectives behind this concept are to (1) reduce the exposure risks to as large a population as possible to levels approaching background, (2) control the maximum individual risk by limiting the maximum concentration of total radium to that allowed and considered acceptable by EPA, and (3) minimize the possibility that additional site remediation would be necessary in the event that contaminant-specific ARARs change in the future.

This ALARA concept for the Residential Areas site and portions of the Kress Creek site is parallel in some respects to the goals outlined by EPA in the National Emission Standards for Hazardous Air Pollutants (NESHAPS) policy considerations for radionuclides (FR 54, No. 240). The radionuclide NESHAPS were geared toward controlling the maximum individual risk to 10^{-4}, while striving to provide protection to the greatest number of persons possible to a risk level no higher than 10^{-6}. A similar philosophy is expressed in recommendations from the International Commission on Radiation Protection (ICRP) in that radiation exposures should be justified, protection from exposures should be optimized, and individual risk limits should be applied to control maximum exposures (ICRP Report 60). The ALARA concept specified for this site provides a mechanism for complying with the concepts outlined in these guidance documents.

For the Residential Areas site and portions of the Kress Creek site, the ALARA concept is stated in terms of EPA's verification criterion for the outdoor soil concentration rather than risk; however, concentration and risk are directly related. The verification criterion for soil concentration is the primary criterion by which removals will be evaluated, and it provides a practical measuring tool for ALARA.

In practice, it is expected that the actual cleanup levels achieved during the Residential Areas site and portions of the Kress Creek site removal action will be generally well below the soil concentration criterion of 5 pCi/g. Because of the imprecise nature of field excavation equipment relative to the typical configuration of contaminated materials in discrete layers or pockets, and to allow for uncertainties in field measurements, excavation of contaminated soils will continue until concentrations clearly below the target levels are achieved. Such practices reduce the need for remobilization to excavate additional soils at a later time. Historical cleanup activities conducted by various parties (which have generally targeted the 5/15 pCi/g federal standard) have resulted in residual concentrations well below predetermined criteria and, in many cases, near background levels.

ALARA is implemented in daily operations to protect the public from excessive radiation exposures and to reduce the possibility of radioactivity release to the environment.

Examples of mitigating actions to protect the public and the environment are discussed in Section 5.1. Measures taken to protect the worker will also protect the general public during the removal action. These measures include standard posting protocol, dust suppression, and health physics coverage. Site access control will be maintained through access agreements and verbal communication with property owners/occupants and the general public. Protection of the environment during the removal action can be obtained through measures such as surface wetting to control dust, placing covers over soil piles, installing containment or physical barriers to minimize runoff, and minimizing delays in backfilling and restoring excavated areas.

6.4 Waste Management and Transportation

The ALARA process is also applied when determining how to manage and transport waste generated by the removal activity.

6.4.1 Management of Waste Material

Waste management will involve construction and monitoring of a temporary staging or transloading area for waste prior to shipment for final disposal (base action), construction and monitoring of an interim storage facility (contingent action), or use of special containers, such as for investigation-derived waste (IDW).

In an effort to meet ALARA objectives, the completed transloading area or interim storage facility will be inspected periodically. In addition, specific security measures such as access gates, fences, and warning signs will be inspected regularly. Spills will be promptly cleaned up and contained. The interim storage facility, if constructed, will be engineered to control exposures to the public and the environment.

Investigation-derived waste material from removal activities may be temporarily stored in a secured area to be identified by EPA in drums or appropriate containers such as LSA boxes. Specific guidelines will be followed for inspecting, loading, labeling, and storing the containers so that exposure levels from waste material placed in such containers meet ALARA objectives.

As containers arrive onsite, they will be inspected to verify that they meet the specifications of a DOT 17H specification drum or a DOT Type B-25 strong tight container. Inspections of drums include a visual examination for defects such as dents, punctures, major rust, or deterioration. LSA boxes will be visually inspected for weld deficiencies, dents, paint condition, lid size, clip hooks, skids, and interior deformity (e.g., excess weld material, excess paint, or rust). Certification of approved containers will be recorded on a container inventory sheet; unapproved containers will be sent back to the manufacturer.

Before waste material is loaded, a plastic liner will be placed in each container. The thickness of the liner is based on the proposed disposal or storage site criteria. Radioactive, hazardous, and mixed wastes are segregated and appropriately packaged and labeled in lined containers. While a container is being filled, a record will be maintained of the contents (e.g., type and volume of material). When a container is left unattended, the lid will be replaced and secured to prevent addition of unauthorized material.

Containers of radioactive, hazardous, and mixed wastes will be stored separately on pallets in sheltered areas. Stored containers will be inspected monthly for any signs of deterioration.

6.4.2 Transportation of Waste Material

Written instructions will provide necessary information to appropriate site personnel so that ALARA objectives are met during transport of waste material from the excavation sites to the holding/storage area and from the holding/storage area to final disposal. These instructions will establish requirements to minimize the potential for exposure and release to the environment during handling and transportation so that transport regulations and qualifications are met. For example, each container or bag of waste may be visually inspected and checked for tags/labels prior to loading. During loading, any damaged container or bag (e.g., punctured or crushed) will be removed and the contents placed in a container or bag in good condition. After loading, the exterior surface of the rail car or vehicle will be scanned for the presence of radioactivity and an external radiation field.

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Appendix A

Action Criteria for Superfund Removal Actions at the Kerr-McGee Residential Areas Site West Chicago, Illinois

Prepared by
U.S. Environmental Protection Agency, Region 5

November 1993

ACTION CRITERIA
FOR SUPERFUND REMOVAL ACTIONS
AT THE KERR-McGEE RESIDENTIAL AREAS SITE
WEST CHICAGO, ILLINOIS

Introduction

Under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (commonly known as Superfund), as amended by the Superfund Amendments and Reauthorization Act of 1986, the United States Environmental Protection Agency (U.S. EPA) is authorized, among other things, to take response actions whenever there is a release or threat of a release of a hazardous substance into the environment. The National Priorities List (NPL) is a list of hazardous waste sites across the country that are eligible for U.S. EPA response actions under Superfund.

The U.S. EPA has listed four sites in the vicinity of the City of West Chicago, Illinois, on the NPL. The primary contaminants of concern at these sites are radioactive thorium and its decay products derived from ore processing operations at a factory in West Chicago, now known as the Kerr-McGee Chemical Corporation West Chicago Rare Earths Facility ("factory site"). Three of the NPL sites became contaminated when the processing wastes (thorium mill tailings) were removed from the factory and used primarily as fill material in and around the City of West Chicago. These sites are known as:

(1) Kerr-McGee (Residential Areas) site,
(2) Kerr-McGee (Sewage Treatment Plant) site, and
(3) Kerr-McGee (Reed-Keppler Park) site.

The fourth site became contaminated when discharges and runoff from the factory site traveled via a storm sewer into nearby Kress Creek and downstream to the West Branch of the DuPage River. This site is known as:

(4) Kerr-McGee (Kress Creek/West Branch of DuPage River) site.

It is important to note that the Residential Areas site may encompass not only residential properties, but also institutional, commercial and municipal properties. Although primarily contaminated because thorium mill tailings were used as fill, some of the properties may have become contaminated due to windblown material from the factory site.

The Kerr-McGee factory site from which the contamination originated has not been listed on the NPL; it is regulated under the licensing authority of the Illinois Department of Nuclear Safety (IDNS). Decommissioning, clean-up and closure of the factory site currently is being addressed under that authority.

Purpose and Intent

The purpose of this document is to establish criteria for U.S. EPA's response actions at contaminated properties ("Residential Areas") that are not part of the Sewage Treatment Plant, Reed-Keppler Park or Kress Creek/West Branch of DuPage River sites. Those three NPL sites will be addressed by U.S. EPA in separate actions.

It is the intent of the U.S. EPA to address the contamination problems at the Residential Areas by removal actions wherever practicable. Removal actions generally provide more immediate protection than do long-term remedial actions, and are consistent with the movement in the Superfund program to accelerate site cleanups.

U.S. EPA's actions under Superfund will be limited to those properties where the contamination is attributed to process wastes (thorium mill tailings) from the factory site. When naturally occurring radioactive materials not associated with process wastes cause U.S. EPA's action criteria to be exceeded, any corrective actions will have to take place through a separate mechanism, because Superfund generally does not give U.S. EPA the authority to remediate threats from naturally occurring substances.

This document contains the criteria that U.S. EPA will use to designate properties for removal actions and to verify that cleanup to levels protective of human health and the environment has been achieved. The U.S. EPA does not have standardized criteria for removal actions of this type. Consequently, site-specific criteria have been developed by the U.S. EPA in consultation with the IDNS for use at the Residential Areas. The criteria specified in this document will be used during three separate phases of the cleanup action: the **discovery phase**, the **characterization phase**, and the **verification phase.** Each of these phases and the criteria for each are described in detail later in this document. This document also contains release criteria for releasing equipment from work sites for unrestricted use.

Applicable or Relevant and Appropriate Requirements

Under Superfund, long-term remedial actions must attain Federal and more stringent State "applicable or relevant and appropriate requirements" (ARARs) during and at the completion of the remedial action. Removal actions (such as the type planned at the Residential Areas) must attain ARARs to the extent practicable. Therefore, U.S. EPA relied upon Federal and State ARARs to the extent practicable to establish the criteria in this document.

"Applicable requirements" are cleanup standards or other environmental protection requirements that specifically apply to the substances or activities at the site. In other words, an applicable requirement is one that a private party would have to comply with by law if the same action was being taken apart from Superfund authority.

If a requirement is not applicable, it still may be relevant and appropriate. "Relevant and appropriate requirements" are those cleanup standards that address problems or situations sufficiently similar to those at the Superfund site that their use is well suited to the particular site. A relevant and appropriate requirement must be both relevant to the conditions at the site and appropriate for use at the site, given the circumstances.

If a Federal or State requirement is neither applicable nor relevant and appropriate (and thus not an ARAR), it still may be useful to U.S. EPA when determining the necessary level of cleanup for protection of human health and the environment. Such "to-be-considered" material (TBCs) can include promulgated regulations that do not qualify as ARARs, and non-promulgated advisories or guidance issued by Federal or State government. Superfund actions are not required to meet TBCs.

Only requirements that are duly promulgated under Federal or State law can be ARARs. Additionally, only substantive requirements of regulations, not procedural requirements, can be ARARs for on-site actions.

The U.S. EPA has identified the following major sources of ARARs and TBCs for the cleanup actions at the Residential Areas:

> Title 40, Part 192 of the Code of Federal Regulations (40 CFR 192), entitled "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings" - 40 CFR 192 contains U.S. EPA's standards for cleanup of lands contaminated by uranium and thorium mill wastes. The standards apply only to the sites specifically designated under the Uranium Mill Tailings Radiation Control Act of 1978, but they often have been used as criteria at uranium, thorium and radium sites because of the similarity of the problems. They are not applicable to the Residential Areas, but U.S. EPA considers portions to be relevant and appropriate.
>
> Title 32, Chapter II, Subchapter b, Part 332 of the Illinois Administrative Code, entitled "Licensing Requirements for Source Material Milling Facilities" - These regulations deal with licensing requirements for source material milling facilities in Illinois and apply to the Kerr-McGee factory site in West Chicago. They are not applicable to the Residential Areas, but U.S. EPA considers portions to be relevant and appropriate and portions to be TBCs.
>
> Title 32, Chapter II, Subchapter b, Part 340 of the Illinois Administrative Code, entitled "Standards for Protection Against Radiation" - These regulations establish standards for protection against radiation hazards, primarily in an occupational setting; they control the possession, use and transfer of sources of radiation by "licensees and registrants" so that the total dose to an individual does not exceed specified standards. They also contain decontamination guides for the release of equipment for unrestricted use. These regulations are not applicable to the Residential Areas, but U.S. EPA considers portions to be relevant and appropriate.
>
> DOE Order 5400.5, entitled "Radiation Protection of the Public and the Environment" - This Order establishes standards and requirements for Department of Energy (DOE) operations with respect to protection of members of the public against undue risk from radiation, and contains a discussion of DOE's "ALARA" (As Low As Reasonably Achievable) approach. The Order is not a promulgated Federal or State regulation, and thus cannot be an ARAR, but U.S. EPA considers portions of the Order to be TBCs.

Title 10, Part 20 of the Code of Federal Regulations (10 CFR 20), entitled "Standards for Protection Against Radiation" - These regulations contain the Nuclear Regulatory Commission's standards for protection against radiation, and contain an "ALARA" approach. They are not applicable or relevant and appropriate to the Residential Areas, but U.S. EPA considers portions to be TBCs.

U.S. Nuclear Regulatory Commission's Regulatory Guide 8.37 - This regulatory guide contains, among other things, a discussion of the NRC's "ALARA" approach. The regulatory guide is not a promulgated regulation, and thus cannot be an ARAR, but U.S. EPA considers a portion of the guide to be a TBC.

U.S. Nuclear Regulatory Commission's Regulatory Guide 1.86 - This regulatory guide contains, among other things, decontamination guides for the release of equipment for unrestricted use. The regulatory guide is not a promulgated regulation, and thus cannot be an ARAR, but U.S. EPA considers a portion of the guide to be a TBC.

The Action Criteria

The remainder of this document describes the different phases of the cleanup action, the specific Federal and State requirements that U.S. EPA considers to be ARARs or TBCs, and the resulting action criteria for each phase of the cleanup action.

DISCOVERY AND CHARACTERIZATION PHASES

The first phase of the cleanup action is the **discovery** phase. During this phase, properties in and around the City of West Chicago will be surveyed and sampled to discover and designate those that require cleanup. If a property clearly exceeds the discovery criteria, and if it is clear that the exceedance is due to thorium mill tailings from the factory site, the property will be designated for removal action. If it is not clear whether a property exceeds the discovery criteria (i.e., borderline results), or if it is not clear whether exceedance of the criteria is due to thorium mill tailings, then further investigation will be needed before a decision can be made to designate that property for response action. Such properties will move into the **characterization** phase.

Because the objective of both discovery and characterization is the same (i.e., to find contaminated properties), the action criteria during these two phases are identical. Properties deemed not to exceed the action criteria during either discovery or characterization will be excluded from further consideration.

Due to the nature of the radiological contamination at the Residential Areas, survey efforts during the discovery phase will consist of measuring and/or sampling the following four parameters: outdoor soil concentration, outdoor gamma exposure rate, indoor gamma exposure rate and indoor radon/thoron air concentration.

The primary criterion that will be used to designate a property for response action is outdoor soil concentration. The other three parameters (outdoor gamma exposure rate, indoor gamma exposure rate and indoor radon/thoron air concentration) will be used as indicators or "finding tools" to help locate contaminated areas; elevated readings for any of these three parameters alone generally will not trigger a cleanup action unless combined with soil sampling data that exceeds the soil concentration criterion and confirms the presence of thorium mill tailings.

The U.S. EPA has taken a conservative approach with the discovery and characterization criteria in order to minimize the chances of not discovering properties where contamination actually is present. As a result, the discovery criteria may be more stringent than the verification criteria (e.g., for outdoor soil concentrations, the results will not be averaged over 100 square meters during discovery and characterization, but averaging over 100 m^2 may be conducted during the verification phase).

For indoor radon/thoron, the necessity for expeditious surveillance argues for measurements on a shorter time frame than the annual average (or equivalent) associated with the wording of the relevant and appropriate requirement. In order to not unduly delay assessments, discovery and characterization measurement periods may be on the order of 2 days to 3 months. Since weather, seasons and home usage all influence indoor radon/thoron levels, these shorter measurements may not fully characterize the annual average but should be adequate to serve as "finding tools." Also, many homes may have elevated levels of naturally occurring radon that are not associated with the presence of thorium mill tailings on the property. For these reasons, an elevated reading of indoor radon/thoron will not trigger a cleanup action unless combined with soil sampling data that exceeds the soil concentration criterion and confirms the presence of thorium mill tailings.

Discussed below are the criteria that will be used during the discovery and characterization phases of the response action:

- **Outdoor Soil Concentration**

  Soil standards for mill tailings of the type present at the Residential Areas are found in 40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," and at Section 332.150(b) of the Illinois Administrative Code. None of the standards are applicable to the Residential Areas, but portions are relevant and appropriate. Because the State standard is more stringent than the Federal standard (by specifying that the concentration limit is for dry soil), the State regulation is considered as the ARAR.

  The State regulation at Section 332.150(b) of the Illinois Administrative Code specifies that the licensed site shall be decontaminated to the following limits prior to termination of the license:

"Concentrations of radionuclides in soil above background concentrations for total radium, averaged over areas 100 square meters, shall not exceed:

A) 5 picocuries per gram of dry soil, averaged over the first 15 centimeters below the surface; and

B) 15 picocuries per gram of dry soil, averaged over layers of 15 centimeters thickness more than 15 centimeters below the surface."

The State requirements in Section 332.150(b) of the Illinois Administrative Code were based on the federal standards in 40 CFR 192.12(a). When the federal standards in 40 CFR 192 were developed over a decade ago, the 5 picocuries per gram (pCi/g) standard was a health based standard, but the 15 pCi/g standard for subsurface soil was technology based, reflecting instrument limitations in locating subsurface deposits. The 15 pCi/g limit is not a health-based standard, and should not be applied to situations in which a health-based standard is appropriate, or to situations that differ substantively from those for which it was derived.

The 15 pCi/g limit was developed as a practical measurement tool for use in locating discrete caches of high activity tailings (typically 300-1000 pCi/g) that were deposited in subsurface locations at mill sites or at nearby properties. The subsurface soil standard in 40 CFR 192 was originally proposed as 5 pCi/g. The final standard was changed, not because the health basis was relaxed, but rather in order to reduce the cost to DOE of locating buried tailings - under the assumption that this would result in essentially the same degree of cleanup at the DOE sites as originally proposed under the 5 pCi/g criterion. The use of a 15 pCi/g subsurface criterion allowed the DOE to use field measurements rather than laboratory analysis to determine when buried tailings had been detected. It is only appropriate for use as a cost-effective tool to locate radioactive waste in situations where contaminated subsurface materials are of high activity and are not expected to be significantly admixed with clean soil. The 15 pCi/g subsurface criterion was not developed for situations where significant quantities of moderate or low activity materials are involved, such as at the Residential Areas site. Therefore, the 15 pCi/g subsurface criterion is not appropriate for use at the Residential Areas site, and thus is not an ARAR. The 5 pCi/g standard, on the other hand, was developed as a health-based standard and is appropriate for use at the Residential Areas site.

Although the soil concentration standard in the regulation is written in terms of an average over an area of 100 square meters, areal averaging will not be conducted during discovery and characterization. This approach is conservative and should minimize the chances of not identifying contamination during the discovery and characterization surveys.

Therefore,

> **The Discovery and Characterization Criterion for outdoor soil concentrations will be exceedance of 5 picocuries per gram total radium (radium-226 plus radium-228), dry soil, above background in any 15 centimeter depth based upon Section 332.150(b) of the Illinois Administrative Code.**

- <u>**Outdoor Gamma Exposure Rates**</u>

Section 332.150(b)(2) of the Illinois Administrative Code, "Termination of Source Material Milling Facility License," deals with a site licensed by IDNS that is to be decontaminated for license termination. It states that the licensed site shall be decontaminated to the following limits prior to termination of the license:

> "The level of gamma radiation measured at a distance of 100 centimeters from the surface shall not exceed background."

This regulation applies only to a licensed site, but the requirements are relevant to the Residential Areas since the intent of the standards is to limit public exposure from site-related radioactive materials.

The variability and distribution of naturally-occurring radioactive materials results in a range of normal background levels, even within a small region such as a few mile radius around West Chicago. In part, this originates from variable geological constituents and in part from human actions (such as phosphate fertilization which can add additional radium to the soil). Consequently, there is not a single number that can be said to be "background" for the entire West Chicago region. While not represented by a single number, the normal background levels of gamma exposure rate will fall within a range and in a fairly predictable statistical pattern. Consequently, a statistical method will be applied to both establish background and what is distinctly above background.

Because there are sources unrelated to thorium mill tailings (such as phosphate fertilizers) that could cause elevated gamma readings at the Residential Areas, it is not appropriate to use the background gamma standard during the discovery phase as a strict, single criterion that, in and of itself, triggers cleanup. However, U.S. EPA will use measurements of outdoor gamma exposure rate as a "finding tool" to locate those areas that are statistically distinct from background. Gamma readings found to be statistically distinct from background at a property will be an indication of possible thorium mill tailings contamination. Such areas will, at a minimum, be investigated further. Elevated gamma readings alone generally will not trigger a cleanup action unless combined with soil sampling data that exceeds the soil concentration criterion and confirms the presence of thorium mill tailings.

Because the background gamma standard will be used extensively as a "finding tool" and not as a strict criterion, exposure rates may be measured at varying heights from the ground surface (typically, 0 to 1 meter), depending on detection sensitivities, practicality, and other conditions encountered in the field.

Therefore,

> **The Discovery and Characterization Criterion for outdoor gamma exposure rate will be the statistical exceedance of background based upon the Illinois Administrative Code, Section 332.150(b)(2).**

- <u>**Indoor Gamma Exposure Rates**</u>

The only promulgated standard that specifically deals with indoor gamma exposure rate is 40 CFR 192.12(b)(2), which states that the objective of remedial action shall be that

> "In any occupied or habitable building--...The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour."

Gamma ray exposure to 20 microroentgens per hour for a substantial portion of the year could result in an annual dose exceeding 100 millirem, due solely to external exposure to gamma rays. Recommendations by eminent bodies of radiation scientists, and regulations and policies of federal agencies such as the Nuclear Regulatory Commission and the Department of Energy, are to limit doses to members of the general public to less than 100 millirem per year, including both external exposure (from gamma rays) and internal exposure (from inhalation and ingestion). In addition, NRC's regulations at 10 CFR 20, DOE Order 5400.5 and NRC Regulatory Guide 8.37 contain an "ALARA" (As Low As Reasonably Achievable) approach, which sets forth an objective to attain dose levels as far below the dose limits as practicable. Moreover, EPA believes that individual sources of contamination should be kept to a small fraction of the primary limit of 100 millirem per year, and generally sets annual dose standards below a couple of tens of millirems.

As a result of the above considerations, 40 CFR 192.12(b)(2) is not appropriate for use at the Residential Areas site, and thus is not an ARAR.

Although meant to apply to outdoor situations, the gamma exposure rate standard found at Section 332.150(b)(2) of the Illinois Administrative Code is a TBC for indoor gamma exposure rate, since the intent is to limit public exposure to site-related radioactive materials, and since periods of occupancy are higher indoors than outdoors.

As with outdoor gamma exposure rate, normal background values for indoor gamma exposure rate will fall within a range and in a fairly predictable statistical pattern; background is not a single value and must be treated statistically. In addition, different building materials (such as bricks, concrete blocks and granite hearths) that contain naturally occurring radiological materials could cause elevated indoor gamma readings that are unrelated to thorium mill tailings. For these reasons, U.S. EPA will use measurements of indoor gamma exposure rate as a "finding tool" to locate contaminated areas that may be below or alongside the foundations of buildings. Elevated indoor gamma readings alone generally will not trigger a cleanup action unless combined with soil sampling data that exceeds the soil concentration criterion and confirms the presence of thorium mill tailings.

Therefore,

> **The Discovery and Characterization Criterion for indoor gamma exposure rate will be the statistical exceedance of background, based upon the Illinois Administrative Code, Section 332.150(b)(2).**

As with outdoor gamma exposure rate, a statistical method will be applied to both establish background and what is distinctly above background.

- <u>Indoor Radon/Thoron Decay Product Concentrations</u>

Standards dealing with indoor radon decay product concentrations are found at 40 CFR 192.12(b)(1), which states that:

> "In any occupied or habitable building-- The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL..." (WL, or working levels, is a measure of the concentration of radon decay products.)

While radon-222 (commonly known just as radon) is produced from the Uranium Decay Series, radon-220 (commonly known as thoron) is the Thorium Decay Series form of radon. 40 CFR 192.40(b) states that the provisions of the standard applicable to radon also apply to thoron. U.S. EPA interprets the radon decay product concentration of 0.02 WL at 40 CFR 192.12(b)(1) to represent the combined (total) concentration of decay products from both radon and thoron.

In the absence of the thorium mill tailings, naturally-occurring decay product concentrations consist primarily of radon, with thoron decay product levels at about 25% to 50% of those of radon. However, since the thorium decay series radionuclides dominated in the ores used at the factory site, it is reasonable to assume that contaminated properties may show elevated levels of thoron if tailings are located below or alongside the foundation of a building. However, because of different half lives in the thoron decay series, and depending on the location of the tailings, not every contaminated property will show elevated levels of thoron.

Due to the need for expeditious surveillance, measurements during the discovery and characterization phases will occur over a shorter time frame than the annual average (or equivalent) associated with the wording of the relevant and appropriate requirement. In order to not unduly delay assessments, discovery and characterization measurement periods may be on the order of 2 days to 3 months. Since weather, seasons and home usage all influence indoor radon/thoron levels, these shorter measurements may not fully characterize the annual average but should be adequate to serve as "finding tools."

As with outdoor and indoor gamma exposure rate, there is a natural variability in the range of indoor radon/thoron decay product concentrations. Some areas of West Chicago, as in other parts of the country, may have naturally high levels of indoor radon that are totally unrelated to thorium mill tailings. For these reasons, U.S. EPA will use measurements of indoor radon/thoron decay product concentrations as a "finding tool" to help locate contaminated areas that may be below or alongside the foundations of buildings. Elevated indoor radon/thoron decay product readings alone will not trigger a cleanup action unless combined with soil sampling data that exceeds the soil concentration criterion and confirms the presence of thorium mill tailings.

Therefore,

> **The Discovery and Characterization Criterion for indoor radon/ thoron decay product concentrations is 0.02 WL combined radon and thoron decay products (including background) based upon 40 CFR 192.12(b)(1).**

If a property exceeds this criterion due to naturally-occurring radon, and there is no other indication of thorium mill tailings on the property, the property will not be remediated as part of this Superfund action.

- **"As Low As Reasonably Achievable" (ALARA)**

As discussed above, NRC's regulations at 10 CFR 20, DOE Order 5400.5 and NRC Regulatory Guide 8.37 all contain an ALARA approach which sets forth the objective to attain dose levels as far below the dose limits as practicable. These requirements are TBCs for the removal actions at the Residential Areas.

In addition, Section 340.1000(b) of the Illinois Administrative Code is a TBC for the removal actions at the Residential Areas. Section 340.1000(b), which applies to "licensees and registrants," states,

> "In addition to complying with the requirements set forth in this Part, every reasonable effort should be made to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable. The term 'as low as is reasonably achievable' means as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of ionizing radiation in the public interest."

The NRC regulations at 10 CFR 20 contain similar language.

As a result, during discovery and characterization, the following ALARA approach will be used for the Residential Areas site:

> **Every reasonable effort should be made to maintain radiation exposures, and the amount of radioactive materials in unrestricted areas, to levels that are as low as is reasonably achievable.**

VERIFICATION PHASE

Once a property has been designated for a removal action, the success of the operation must be verified during and at the completion of the removal action. During the verification phase, properties will be surveyed and sampled to ensure that cleanup to levels protective of human health and the environment has been achieved.

As indicated below, some of the verification criteria will be applied during and immediately following the removal action, with surveys and samples collected before the open excavation is backfilled with clean material. Some of the verification criteria will be applied later, with surveys and samples collected after the excavation is backfilled.

The criteria to be used during the verification phase are as follows:

- Outdoor Soil Concentrations

> **The Verification Criterion for this parameter will be soil concentrations that do not exceed 5 picocuries per gram total radium (radium-226 plus radium-228), dry soil, above background, averaged over areas up to 100 square meters, in any 15 centimeter depth based upon Section 332.150(b) of the Illinois Administrative Code.**

Samples for outdoor soil concentrations will be collected before backfilling.

- **Outdoor Gamma Exposure Rates**

During cleanup of a property, as during the discovery and characterization phases, outdoor gamma exposure rates will be used as a "finding tool" to help determine where additional excavation may be needed. The main criterion to determine when excavation can cease, however, is the outdoor soil concentration criterion.

However, Section 332.150(b)(2) of the Illinois Administrative Code (which requires that, prior to termination of the license, the licensed site be decontaminated so that "The level of gamma radiation measured at a distance of 100 centimeters from the surface shall not exceed background") is relevant to the Residential Areas, and is appropriate for application at the completion of a cleanup action at a property.

Therefore,

> **The Verification Criterion for this parameter will be outdoor gamma exposure rates that do not statistically exceed background at a distance of 100 centimeters from the surface, based upon the Illinois Administrative Code, Section 332.150(b)(2).**

Outdoor gamma exposure rate surveys to verify that this criterion has been met will be conducted after backfilling. A statistical method will be applied to both establish background and what is distinctly above background.

- **Indoor Gamma Exposure Rates**

For properties that require cleanup and that were found, during discovery and characterization, to have elevated levels of indoor gamma exposure rate due to thorium mill tailings contamination on the property, indoor gamma exposure rate surveys will be used during the cleanup action as a "finding tool" to help determine if additional excavation is necessary.

> **The Verification Criterion for this parameter will be indoor gamma exposure rates that do not statistically exceed background based upon the Illinois Administrative Code, Section 332.170(c).**

For properties that require cleanup, but for which no elevated indoor gamma readings were found during discovery and characterization, indoor gamma surveys will not be conducted during the verification phase.

- **Indoor Radon/Thoron Decay Product Concentrations**

For properties that require cleanup and that were found, during discovery and characterization, to have elevated levels of indoor radon/thoron decay product concentrations due to thorium mill tailings contamination on the property, additional surveys will be conducted at the completion of the cleanup action to determine if the following verification criterion has been met:

In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) combined radon and thoron decay product concentration (including background) not to exceed 0.02 WL. In any case, the combined radon and thoron decay product concentration (including background) shall not exceed 0.03 WL. (Based on 40 CFR 192.12(b)(1).)

For properties that require cleanup, but for which no elevated indoor radon/thoron decay product concentrations due to thorium mill tailings were found during discovery and characterization, indoor radon/thoron testing will not be required during the verification phase.

- **"As Low As Reasonably Achievable" (ALARA)**

  In addition to meeting the verification criteria described above, the following ALARA approach will be used during cleanup actions:

  Every reasonable effort should be made to maintain radiation exposures, and the amount of radioactive materials in unrestricted areas, to levels that are as low as is reasonably achievable.

RELEASE CRITERIA

In addition to the above criteria for discovery, characterization and verification, it will be necessary throughout the project to release equipment from work sites and it may be necessary to assess whether materials or surfaces are suitable for unrestricted use. Requirements for such situations are found in the Illinois Administrative Code, Section 340, Appendix C(a); these requirements are relevant and appropriate for use at the Residential Areas. Similar requirements also are found in the U.S. Nuclear Regulatory Commission's Regulatory Guide 1.86, Table 1; these guidelines are not ARARs (since only promulgated regulations can be ARARs), but the U.S. EPA does consider them to be TBCs.

Both sets of requirements are shown below. Since the requirements are set up with differing units, the most restrictive part for a given situation would be used.

- **Illinois Administrative Code, Section 340, Appendix C(a)**

DECONTAMINATION GUIDES

a) Surface Contamination Guide

<u>Alpha Emitters</u>

Removable	15 pCi per 100 cm^2 = 33 dpm per 100 cm^2	average over any one surface
	45 pCi per 100 cm^2 = 100 dpm per 100 cm^2	maximum
Total (fixed)	450 pCi per 100 cm^2 = 1,000 dpm per 100 cm^2	average over any one surface
	2,250 pCi per 100 cm^2 5,000 dpm per 100 cm^2	maximum
	0.25 mRem per hour at 1 cm	

<u>Beta-Gamma Emitters</u>

Removable (all beta-gamma emitters except Hydrogen 3)	100 pCi per 100 cm^2	average over any one surface
	500 pCi per 100 cm^2	maximum
Removable (Hydrogen 3)	1,000 pCi per 100 cm^2	average over any one surface
	5,000 pCi per 100 cm^2	maximum
Total (fixed)	0.25 mRem per hour at 1 cm from surface	

- **U.S. Nuclear Regulatory Commission, Regulatory Guide 1.86, Table 1**

TABLE 1

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDE [a]	AVERAGE [b,c]	MAXIMUM [b,d]	REMOVABLE [b,e]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α per 100 cm^2	15,000 dpm α per 100 cm^2	1,000 dpm α per 100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm per 100 cm^2	300 dpm per 100 cm^2	20 dpm per 100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm per 100 cm^2	3000 dpm per 100 cm^2	200 dpm per 100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000 dpm ß-γ per 100 cm^2	15,000 dpm ß-γ per 100 cm^2	1000 dpm ß-γ per 100 cm^2

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Criteria Not Chosen for Discovery, Characterization or Verification

Discussed below are other parameters and their associated regulations and standards that were reviewed by U.S. EPA to determine whether they were ARARs and should be used as discovery, characterization and/or verification criteria. None of these standards is applicable to the removal action and, as explained below, none is relevant and appropriate.

- **Outdoor Radon Concentrations**

  Outdoor radon (radon-222) and thoron (radon-220) are regulated in Section 332.170(b) of the Illinois Administrative Code:

  > "During the operating life and facility decommissioning, the combined concentration of radon and thoron at the boundary of the licensed site, measured at a height of one meter from the surface, averaged annually, shall not exceed three picocuries per liter above the background concentration at the licensed site."

  Even though on its terms the regulation applies only to a licensed facility, the intent of the regulation is to control radon and thoron in off-site areas, since the point of compliance is at the boundary of the licensed site. Therefore, the U.S. EPA considers the regulation to be relevant to the Residential Areas.

  However, there are practical reasons why measurements for radon and thoron outdoors will not aid in the identification of contaminated properties not otherwise identified by outdoor gamma exposure rate surveys and outdoor soil concentration samples. These reasons are as follows: (1) Reliable radon and thoron measurements are not immediate, but can take days or weeks to measure good averages. Gamma surveys, on the other hand, can provide instantaneous measurements; (2) Unless the emissions are extremely large, radon and thoron emitted from the ground surface will rapidly mix in the open air, making them indistinguishable from naturally occurring radon and thoron. Large radon and thoron emissions would be associated with large contaminant deposits easily identifiable by gamma survey instruments; (3) Because radon and thoron are gases that can be transported by the wind, it would be much harder to pinpoint the emission site.

  Therefore, for the reasons stated above, outdoor radon concentrations (radon and thoron), though relevant, are not appropriate to these circumstances and will not be one of the criteria for this response action.

- **Radon Release Rates from Soil**

  The emission of radon (radon-222) and thoron (radon-220) from soils is regulated in Section 332.170(c) of the Illinois Administrative Code, which states:

> "The disposal area shall be designed so that after reclamation and stabilization, the annual total radon release rate through the cover from the byproduct material shall not exceed two picocuries per square meter per second."

This regulation only applies to the disposal area at a licensed facility, but the intent of the regulation is to control the total radon emission to the environment and to protect the general population.

However, Section 332.240(a) of the Illinois Administrative Code states:

> "Monitoring for total radon after installation of an appropriately designed cover is not required. Total radon emissions from cover material shall be estimated as part of developing a closure plan."

Since it appears that the State never intended that actual measurements be made to show compliance with the regulation, the U.S. EPA does not consider this regulation to be relevant and appropriate for use at the Residential Areas. In addition, there are other, practical reasons why measurements of radon and thoron emissions from soil would not be an appropriate indicator of contaminants. At the Residential Areas, thoron is the dominant radon isotope of concern. If thoron is produced at a depth of more than a few inches below the ground surface, it will radioactively decay to a solid element and cease moving through the soil before reaching the surface. Soil sampling, on the other hand, will find contaminants at much greater depth, as would gamma exposure rate measurements which penetrate soil depths on the order of several feet.

Consequently, measurements for radon and thoron emission rates will not be conducted during this response action.

- **Doses in the General Environment**

Thorium-related doses in the general environment are regulated in 40 CFR 192.41(d), which states:

> "Operations...shall be conducted in such a manner as to provide reasonable assurance that the annual dose equivalent does not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public as a result of exposures to the planned discharge of radioactive materials, radon-220 and its daughters excepted, to the general environment."

Doses in the general environment also are regulated in Section 332.170(a) of the Illinois Administrative Code, which states:

> "At all times, concentrations of radioactive material, excluding radon, thoron, and their progeny, which may be released to the general environment in groundwater, surface water, air, soil, or other means shall not result in a committed effective dose in excess of 25 millirem (0.25 mSv) to the whole body, and a

committed dose equivalent in excess of 75 millirem (0.75 mSv) to the thyroid, and 25 millirem (0.25 mSv) to any other organ of any member of the public."

* mSv designates milliSieverts, a dose unit equal to 100 millirem.

Neither of the above regulations is applicable to the Residential Areas, but the U.S. EPA considers both to be relevant.

Even though the dose requirements of 40 CFR 192.41(d) and Section 332.170(a) of the Illinois Administrative Code are relevant to the Residential Areas, there are practical reasons why performing dose assessment calculations will not aid in the identification of contaminated properties not otherwise detected by the other discovery criteria. An operational assumption for this response action is that where site parameters such as indoor or outdoor gamma exposure rate, outdoor soil concentrations, or indoor radon and thoron are elevated, dose is elevated proportionally. Therefore, having specific dose calculations is not appropriate as it will not provide useful information not already provided by other parameters. Consequently, no separate dose assessment calculations will be required for this response action.

Appendix B

Potential Applicable or Relevant and Appropriate Requirements

Appendix B
Potential Applicable or Relevant and Appropriate Requirements

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) specifies that removal actions for cleanup of hazardous substances must comply to the extent practicable with requirements or standards under federal or more stringent state environmental laws that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site. Inherent in the interpretation of applicable or relevant and appropriate requirements (ARARs) is the assumption that protection of human health and the environment is provided. ARARs apply to those federal and state regulations that are designed to protect the environment and do not generally apply to occupational safety regulations. Therefore, the Occupational Safety and Health Administration (OSHA) regulations are not addressed as ARARs unless they specifically apply to removal action goals.

The purpose of this appendix is to supply a preliminary list of available federal and state contaminant- and location-specific ARARs for the Residential Areas site and portions of the Kress Creek site. The process of ARAR identification is an iterative one that is continually changing as the removal action progresses. Therefore, this list of ARARs represents a compilation of potential ARARs, of which subsets will be used or additional ARARs added as site-specific contamination at the Residential Areas site is further characterized.

The contaminants of concern at the Residential Areas site and portions of the Kress Creek site are metals (e.g., lead, barium, chromium) and radionuclides from the mill tailings. The probable radionuclides of concern include thorium-232, uranium-238, and the products in the decay chain.

The following is a definition of terms used throughout this appendix:

Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically addresses a hazardous substance, pollutant, contaminant, removal action, location, or other circumstance at a CERCLA site" (52 FR 32496, August 27, 1987).

Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable to a hazardous substance, pollutant, contaminant, removal action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (52 FR 32496).

Requirements under federal or state law may be either applicable or relevant and appropriate to CERCLA cleanup actions, but not both. However, requirements must be both relevant and appropriate for compliance to be required. In the case where a federal and a state ARAR are available, or where there are two potential ARARs addressing the same issue, the more stringent regulation must be selected.

CERCLA onsite response actions must only comply with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA §121(e)]. To proceed with CERCLA response actions as rapidly as possible, the Environmental Protection Agency (EPA) has reaffirmed this position in the final National Contingency Plan (NCP) (55 FR 8756, March 8, 1990). Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation. Response actions implemented offsite need to comply with both administrative as well as substantive regulatory requirements.

In the absence of federal- or state-promulgated regulations, there are other criteria, advisories, guidance values, and proposed standards that are not legally binding, but may serve as useful guidance for setting protective cleanup levels. These are not potential ARARs, but are "to-be-considered" (TBC) guidance.

Contaminant-Specific ARARs

Contaminant-specific requirements set health- or risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants (52 FR 32496). These requirements generally set protective cleanup levels for the contaminants of concern in the designated media, or else indicate a safe level of discharge that may be incorporated when considering a specific removal activity. Little legislation or guidance is available governing cleanup criteria for contaminated soils at CERCLA sites.

Table B-1 summarizes the potential contaminant-specific requirements; specific information included in the table is the title and citation for the potential ARAR, a description of the requirements, a preliminary determination as to relevance (e.g., applicable, relevant and appropriate, or TBC), and any explanatory comments.

Radiation Protection Standards and Other Action-Specific ARARs

Performance, design, or other action-specific requirements set controls or restrictions on particular kinds of activities related to the management of hazardous waste (52 FR 32496). Selection of a particular removal action at a site will invoke the appropriate action-specific ARARs that may specify particular performance standards or technologies, as well as specific environmental levels for discharged or residual chemicals.

Table B-1
Potential Contaminant-Specific Requirements for the Residential Areas Site

Potential ARAR	Requirements	Preliminary Determination	Comments
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40 CFR 192)	Specifies that concentrations of radium-226 and radium-228 in soil averaged over any 100 m^2 area may not exceed background by more than 5 pCi/g in the top 15 cm of soil or 15 pCi/g in any 15-cm layer below the surface layer. Specifies that within any habitable structure, gamma radiation exposure may not exceed 20 μR/hr above background, and radon decay product concentrations may not exceed 0.03 WL and should not exceed 0.02 WL where reasonably achievable.	Portions are relevant and appropriate (see Appendix A for application to the action criteria)	The standards apply only to the sites specifically designated under the Uranium Mill Tailings Radiation Control Act of 1978, but they have often been used as criteria at uranium, thorium and radium sites because of the similarity of problems.
Licensing Requirements for Source Material Milling Facilities (Title 32, Chapter II, Subchapter b, Part 332 of the Illinois Administrative Code)	Prior to termination of the license: Concentrations of radionuclides in soil above background concentrations for total radium, averaged over areas of 100 m^2, shall not exceed: (A) 5 pCi/g of dry soil, averaged over the first 15 cm below the surface; and (B) 15 pCi/g of dry soil, averaged over layers of 15 cm thickness more than 15 cm below the surface. The level of gamma radiation measured at a distance of 100 cm from the surface shall not exceed background.	Portions are relevant and appropriate, and portions are TBCs (see Appendix A for application to the action criteria)	Establishes procedures, criteria, and conditions upon which IDNS issues specific licenses for source material milling and disposal of the byproduct material.
Standards for Protection Against Radiation (Title 32, Chapter II, Subchapter b, Part 332 of the Illinois Administrative Code) Radiation Protection of the Public and the Environment (DOE Order 5400.5) Standards for Protection Against Radiation (10 CFR 20) U. S. Nuclear Regulatory Guide 8.37	Every reasonable effort should be made to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable (ALARA). ALARA means taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of ionizing radiation in the public interest.	Portions are relevant and appropriate (see Appendix A for application to the action criteria) Portions are TBC Portion is TBC Portion is TBC	Some of the verification criteria are applications of ALARA on the standards.

Table B-1
Potential Contaminant-Specific Requirements for the Residential Areas Site

Potential ARAR	Requirements	Preliminary Determination	Comments
Clean Air Act, as amended; National Primary and Secondary Ambient Air Quality Standards (40 CFR 50)	Establishes National Primary and Secondary Ambient Air Quality Standards for certain pollutants, including total particulate matter	Potentially applicable	Excavation equipment exhaust and fugitive dust could potentially contribute to air quality deterioration.
Federal Water Pollution Control Act, Clean Water Act: Water Quality Standards (40 CFR 131), National Pollutant Discharge Elimination System (40 CFR 122-125)	Establishes water quality standards for surface waters and pretreatment standards for waste waters released to publicly-owned treatment works	Potentially applicable	Any wastewater resulting from the proposed action will be managed in accordance with the NPDES process.
Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (EPA/540/R-93/081; February 1994)	Establishes an interim soil cleanup level for total lead at 400 ppm, which EPA considers protective for direct contact at residential settings.	TBC	This directive provides a strong scientific basis for choosing a soil lead cleanup level for a specific CERCLA (residential) site based on EPA's Uptake Biokinetic (UBK) model

The Atomic Energy Act (AEA) of 1954 and its amendments delegated authority for control of nuclear energy to the Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), and EPA. In addition, certain states have regulatory authority and programs for radioactive materials; Illinois is an agreement state with the NRC. EPA's regulations are derived from several other statutes as well and cover many types of activities and radioactive materials. The NRC licenses the possession and use of various types of radioactive materials at certain types of facilities. Table B-2 lists the State of Illinois, EPA, and NRC radiation protection standards that are described below.

EPA Regulations

Subparts T and I of 40 CFR 61, the National Emission Standards for Hazardous Air Pollutants (NESHAPs), addresses atmospheric radionuclide emissions, and may be applicable to airborne emissions during site cleanup. Subpart I limits radionuclide emissions to the ambient air so as not to exceed those amounts that would cause an effective dose equivalent of 10 mrem/year to any member of the public (40 CFR 61.102). EPA has issued a final rule (54 *FR* 51654, December 15, 1989) that limits emissions of radon-222 to the ambient air from uranium mill tailing piles at levels not exceeding 20 pCi/m^2/s (40 CFR 61.222).

The provisions of the Uranium Mill Tailings Radiation Control Act (40 CFR 192) are designed to regulate the stabilization, disposal, and control of uranium and thorium mill tailings. However, these regulations may be relevant and appropriate to cleanup of the Residential Areas site since it contains tailings.

NRC Regulations

The standards for protection against radiation (10 CFR 20) are designed to limit radiation exposures from NRC-licensed activities. They provide permissible worker exposure limits for restricted areas of 5 rem/year (10 CFR 20.1201) and lower radiation exposure limits to the general public in unrestricted areas of 100 mrem/year (10 CFR 20.1301). More specifically, dose limits to the public are as follows:

- 50 mrem/year committed effective dose equivalent (CEDE) as a result of the inhalation of effluent radionuclides (10 CFR 20.1302)

- 50 mrem/year CEDE as a result of the ingestion of effluent radionuclides (10 CFR 20.1302)

- 50 mrem/year effective dose equivalent (EDE) as a result of external gamma radiation (10 CFR 20.1302)

- 100 mrem/year total effective dose equivalent (TEDE) by any combination of inhalation, ingestion, or external doses (10 CFR 20.1301)

Table B-2
Potential Radiation Protection Standards for the Residential Areas Site

Regulation	Applicability	Exposure Conditions	Standard
40 CFR 61	NESHAPs for radionuclides.	Radon release Radionuclide emissions to ambient air	20 pCi/m^2-s Ra-222 from tailing piles 10 mrem/yr effective dose equivalent
40 CFR 192	Uranium and thorium mill tailings. Portions of 40 CFR 192 are considered relevant and appropriate (see Appendix A for application to the action criteria).	Radon (222) emissions Indoor radon (220 and 222) decay products Radium-226 in soil Indoor gamma radiation	20 pCi/m^2/s release over entire site or 0.5 pCi/L air outside site 0.02 working level (WL) as practical. Not to exceed 0.03 WL (includes background). 5 pCi/g over background in top 15 cm averaged 100 m^2 15 pCi/g in 15-cm layers, >15 cm deep over background, averaged 100m^2 20 μR/hr above background
10 CFR 20	Radiation from NRC-licensed facilities.	Worker exposure limits in unrestricted areas Public exposure, unrestricted areas	5 rem/year[a] 100 mrem/year[a]
10 CFR 61	Licensing requirements for land disposal of radioactive waste.	Public exposure, all sources	25 mrem/year (total body) 75 mrem/year (thyroid)
IDNS, Radiation Protection, Part 332	Disposal of source material milling by-product. Portions are considered relevant and appropriate (see Appendix A for application to the action criteria).	Total radium in soil averaged over 100m^2 Gamma radiation Annual radon emissions through cover	5 pCi/g over background in top 15 cm 15 pCi/g in 15-cm layers, >15 cm deep Below background at 100 cm from surface 2 pCi/m^2/s

[a]Final rule of May 22, 1991 (56 FR 23360), effective January 1, 1993.

The NRC has promulgated licensing requirements for land disposal of radioactive waste (10 CFR 61). Part 61 contains procedural requirements and performance standards applicable to land disposal, with specific technical requirements for near-surface disposal of radioactive waste. 10 CFR 61.41 states that concentrations of radioactive materials released to the environment in all media must not result in an annual dose exceeding 75 mrem to the thyroid and 25 mrem to total body or all other organs of any member of the public. In addition, reasonable effort must be made to maintain releases of radioactive materials to "as low as reasonably achievable" (ALARA). 10 CFR 61.43 states that inadvertent intruders must be protected following cessation of active institutional controls, and 10 CFR 61.43 provides that operations at land disposal facilities must be carried out in compliance with 10 CFR 20.

State Regulations

The provisions of Illinois Department of Nuclear Safety (IDNS) Part 332, Licensing Requirements for Source Material Milling Facilities, are designed to regulate source material milling and disposal of the byproduct material. The decontamination requirements influence the cleanup levels for a removal alternative. The requirements concerning the final disposal area may be considered relevant and appropriate for source removal alternatives.

TBC Guidance for Radiological Contaminants

The EPA Office of Radiation Programs has derived slope and unit risk factors for radionuclides of concern at removal sites for each of three major exposure pathways (inhalation, ingestion, and external exposure to contaminated soil). These are available in the EPA Health Effects Assessment Summary Tables (HEAST).

Section 50.51, "Duration of License, Renewal," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that each license to operate a production and utilization facility be issued for a specific duration. Upon expiration of the specified period, the license may either be renewed or terminated by the Commission. Section 50.82, "Applications for Terminations of Licenses," specifies the requirements that must be satisfied to terminate an operating license, including the requirement that the dismantlement of the facility and disposal of the component parts not be inimical to the common defense and security or the health and safety of the public. Regulatory Guide 1.86 describes methods and procedures considered acceptable by the regulatory staff for the termination of operating licenses for nuclear reactors. Table B-3 shows radioactive surface contamination levels considered acceptable for release of a licensed facility for unrestricted use by the NRC. These standards may be used to assess the acceptable levels of contamination remaining on solid items.

Table B-3
Acceptable Surface Contamination Levels

Nuclide[a]	Average[b,c]	Maximum[b,d]	Removable[b,e]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.
[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute (cpm) observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
[c]Measurements of average contaminant should not be average over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.
[d]The maximum contamination level applies to an area of not more than 100 cm^2.
[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Information from Table 6-6 and Table 7-7 of "Risk Assessments Methodology, Environmental Impact Statement, NESHAPs for Radionuclides, Background Information Document" (Volume 1) may also be considered as TBC.

Transportation

The Hazardous Materials Transportation Act, as amended by the Hazardous Materials Transportation Uniform Safety Act (49 CFR 171-177) establishes the requirements for transportation of hazardous (including radioactive) materials, including classification, packaging, labeling, marking, shipping, and placarding requirements. This standard is considered potentially applicable as an ARAR, specifically with regard to transportation of radioactive materials offsite. It is anticipated that all wastes generated during the proposed removal action will contain radioactivity concentrations below 2,000 pCi/g, the threshold subject to classification as radioactive material under these transportation regulations.

Location-Specific ARARs

Location-specific requirements "set restrictions upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations" (53 FR 51394). Table B-4 lists the major federal location-specific ARARs that might be pertinent to removal actions at the Residential Areas site and portions of the Kress Creek site. These will be considered further as site-specific removal alternatives are selected for cleanup.

Caves, Salt-Dome Formations, Salt-Bed Formations, and Underground Mines

There are no indications of caves, salt-dome formations, salt-bed formations, or underground mines on or near the Residential Areas site or portions of the Kress Creek site.

Faults

There are no known faults near the Residential Areas site or portions of the Kress Creek site. The possibility of fault movement is considered unlikely.

Wilderness Areas, Wildlife Refuges, and Scenic Rivers

Two forest preserves are located within a portion of the Residential Areas site or portions of the Kress Creek site. In the event that a removal action could impact the forest preserve, consultation with the managing agency would be needed. The Residential Areas site and portions of the Kress Creek site do not contain either wild and scenic rivers or designated wildlife refuges, based on the current site information.

Table B-4
Tentative Location-Specific ARARs for the Residential Areas Site

Location	Requirement	Prerequisite(s)	Citation
Wetland	Must take action to avoid adverse impact, minimize potential harm, and to preserve and enhance wetlands to the extent possible.	Wetland as defined in 40 CFR 6, Appendix A, Part 4; action of federal agencies involving construction of facilities or management of property in wetland areas.	Executive Order 11990; Protection of Wetlands (40 CFR 6, Appendix A); 40 CFR 6.302(a)
	Federal agencies shall incorporate floodplain management goals and wetlands protection considerations in its planning, regulatory, and decisionmaking process.		40 CFR 6, Appendix A
	Federal agencies should avoid new construction in wetlands areas.		40 CFR 6, Appendix A
	Prohibits discharge of dredge or fill material into wetlands without permit.	Wetlands as defined in 40 CFR 6, Appendix A, Part 4, and the U.S. Army Corps of Engineers regulations	CWA Part 404; 40 CFR 230.10; 33 CFR 320-330
	Provides for the enhancement, restoration, or creation of alternate wetlands.	Unavoidable adverse impacts on wetlands	CWA Part 404(b)(1)
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout by a 100-year flood.	RCRA hazardous waste; treatment, storage, or disposal	40 CFR 264.18(b)
Within floodplain	Must take action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values, and minimize impact of floods on human safety, health, and welfare.	Action of federal agencies pertaining to: acquiring, managing, and disposing of lands and facilities; construction or improvements; and conducting activities and programs affecting land uses in flood-prone areas.	Executive Order 11988; Floodplain Management (40 CFR 6, Appendix A); 40 CFR 6.302(b)
	Federal agencies must evaluate the potential effects of any action it may take in a floodplain, ensuring that planning programs and budget reflect considerations of flood hazards.		Executive Order 11988

Table B-4
Tentative Location-Specific ARARs for the Residential Areas Site

Location	Requirement	Prerequisite(s)	Citation
Within area affecting stream or river	Must take action to protect affected fish or wildlife resources; prohibits diversion, channelling, or other activity that modifies a stream or river and affects fish or wildlife. Federal agencies should consult with the Fish and Wildlife Service and state personnel to develop protective measures for affected wildlife.	Presence of fish and wildlife resources; action by federal agencies resulting in the control or structural modification of a natural stream or body of water. Offsite response actions.	Fish and Wildlife Coordination Act (16 USC 661 et seq.); 40 CFR 6.302(g)
Critical habitat upon which endangered or threatened species depends	Action to conserve endangered or threatened species, including consultation with the Department of the Interior.	Determination of endangered or threatened species.	Endangered Species Act of 1973 (16 USC 1531 et seq.); 50 CFR, Part 200; 50 CFR, Part 402
Historic Sites and Archaeological Findings	Must take action to avoid adverse impact, and to preserve historic sites and archeological findings.	Identification of historic sites and archaeological findings that could potentially be affected by remediation actions	National Historic Preservation Act (36 CFR m Part 800) and National Archaeological and Historic Preservation Act (36 CFR Part 65)

Wetlands and Floodplains

Because the Residential Areas site is adjacent to the Kress Creek site, individual properties may contains both wetlands and floodplains. As a result, the requirements found in the Resource Conservation and Recovery Act (RCRA) 40 CFR 264.18(b), 40 CFR 6 (Appendix A), 40 CFR 230.10, 33 CFR 320-330, and in Executive Orders 11988 and 11990, along with Section 404 of CWA (Table B-2), may be ARARs.

Historic Sites and Archaeological Findings

Northeastern Illinois contains records of prehistoric and historic settlements. Although the Illinois Historic Preservation Agency does not report any archaeological sites at or in close proximity to the Kerr-McGee Rare Earths Facility, field surveys and test excavations at the nearby Fermi National Accelerator Laboratory uncovered numerous prehistoric remains (NRC, 1989).

DuPage County possesses a large number of historic structures (e.g., houses, churches, mills, and taverns), twenty of which are listed in the *National Register of Historic Places*. In addition to two *National Register* properties (McAuley School District No. 27 and Turner Town Hall), the West Chicago area contains a number of nineteen-century buildings (private and public), some of which are currently listed in the state register (NRC, 1989). If historic sites or archeological findings are revealed at the Residential Areas site or portions of the Kress Creek site during the removal investigation, the National Historic Preservation Act (36 CFR Part 800) and the National Archaeological and Historic Preservation Act (36 CFR Part 65) may be applicable.

Rare, Threatened, or Endangered Species

Rare, threatened, and endangered species in the area of the Residential Areas site and portions of the Kress Creek site have been preliminarily identified in the Blackwell Forest Preserve. State-listed endangered species include the following:

- Yellow-Headed Blackbird
- Black Tern
- Common Moorhen
- Black-Crowned Night Heron

Federally listed endangered species include the following:

- Indiana Bat
- Eastern Prairie Fringed Orchid
- Prairie Bush Clover

Therefore, the Endangered Species Act of 1973 (50 CFR 200,402) may be applicable. Currently, critical habitats for these species have not been identified at the Residential Areas site or portions of the Kress Creek site.

Fish and Wildlife

The Kress Creek passing through some portions of the Residential Areas site provides a fish and wildlife habitat. As a result, the Fish and Wildlife Coordination Act [16 U.S.C. 661, 40 CFR 6.302(g)] that prohibits activities that may modify streams and rivers and potentially impact fish or wildlife is a potential ARAR.

Additional ARARS for Portions of the Kress Creek Site

Contingency C, Recontamination Prevention, of Alternative 2, Source Removal, considers installing a barrier wall of steel sheet piling along the creek banks to an elevation that will protect the floodplains from a 100-year recurrence flood. Potential ARARs dealing with this recontamination prevention measure are as follows:

- Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) prohibits the obstruction or alteration of navigable waters of the U.S. without a permit from the U.S. Army Corps of Engineers (USACE). These permits are primarily informational, and stream protection during pile installation will be the primary requirement. Contingency C will likely require compliance with (action-specific ARAR) Section 10 USACE permit process.

- For installation of the piling within the 100-year floodplain, 40 CFR 264.18(b) (RCRA) is not directly applicable because the Contingency C activity is not intended to prevent contamination from entering a stream during a flood.

- The Rivers, Lakes, and Streams Act (Ill. Rev. Stat. 1991, ch. 19, pars. 52-79) [615 ILCS 5], Section 404 of the Federal Water Pollution Control Act of 1972, as amended (30 U.S.C. 1344), and the Clean Water Act of 1977, Section 404 (40 CFR Parts 230 and 231) would apply if wetlands were disturbed by filling during sheet pile installation, or if the installation affected the flow of the waterway.

- Federal Emergency and Management Association (FEMA), Illinois Department of Transportation (IDOT) Department of Water Resources (DWR), and DuPage County all have (location- and action-specific ARAR) requirements. Most applicable are floodplain volume mitigation requirements. These require the design capacity of channels subject to temporary and permanent stream channel impacts to be at least equal to the capacity of the unmodified stream channel immediately upstream and downstream from the diversion. This typically requires flood volume mitigation; when an existing floodway is restricted, additional volume must be provided to mitigate the impact of flooding.

State ARARs for Environmental Protection

Title 35 of the Illinois Administrative Code is the Environmental Protection Act, administered by the Illinois Environmental Protection Agency. Table B-5 lists the potential contaminant-specific ARARs from Title 35, and Table B-6 lists the potential action-specific ARARs.

Table B-5
Contaminant-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Part 212	Visual and Particulate Matter Emissions. This part addresses standards and limitations for visual and particulate matter from stationary sources. Subpart A (212.100 through 212.113) dictates the measurement methods for opacity and particulate matter. Subpart K (212.301 through 212.324) addresses the regulation of fugitive particulate matter emissions from any process, including any material handling or storage activity, that is visible by an observer looking generally toward the zenith at a point beyond the property line of the emission source.	Portions are applicable.	This applies to material excavation and storage pile management activities.
Part 243	Illinois Air Quality Standards. This part addresses the limits on atmospheric concentrations of air contaminants established for the purpose of protecting public health and welfare. Subpart A (243.104 through 243.108) establishes that if the existing ambient air quality is better than established ambient air quality standards, the existing air shall be maintained at its present high quality. The remainder of this subpart discusses monitoring requirements and reference conditions for all measurements of air quality. Subpart B (243.121 through 243.126) establishes the standards and measurement methods for monitoring the following contaminants: sulfur oxides (as sulfur dioxide), carbon monoxide, nitrogen dioxide, ozone, and lead.	Portions are relevant and appropriate.	This rule sets the air quality standards for the state with which everyone must comply.
Part 302	Water Quality Standards. This part contains schedules of water quality standards that are applicable throughout the state. Subpart B (302.208 and 302.210) contains general use water quality standards for specific chemical constituents and other toxic substances. Subpart C (302.304) contains public and food processing water supply standards for specific chemical constituents.	Portions may be relevant and appropriate.	This rule establishes the general water quality standards of the state.

Table B-5
Contaminant-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Part 304	Effluent Standards. This part prescribes the maximum concentrations of various contaminants that may be discharged to the waters of the state. Subpart A (304.102 through 304.141) contains general effluent limitations. Subpart C (304.301) contains temporary effluent standards.	Portions may be applicable.	This rule sets the minimum standards for effluent discharged into the waters of the state. This rule may apply to stormwater discharges from the project site.
Part 721	Identification and Listing of Hazardous Waste. This part identifies those solid wastes that are subject to regulation as hazardous wastes under Parts 702, 702, 705, 722 through 725, and 728. Subpart A (721.101 through 721.108) contains definitions, identifies wastes that are excluded from regulation under Parts 702, 703, 705, 722 through 726, and 728, and addresses requirements for small quantity generators. Subpart B (721.110 through 721.111) sets forth the criteria used to identify characteristics of hazardous waste and lists particular hazardous wastes. Subpart C (721.120 through 720.124) identifies characteristics of hazardous wastes. Subpart D (721.130 through 721.133) lists particular hazardous wastes.	Portions may be relevant and appropriate.	

Table B-6
Action-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Part 201	Illinois Permits and General Air Pollution Regulations. This part addresses the general air pollution control regulations and requirements for permitting emission sources. Subpart C (201.141 through 201.151) discusses prohibitions and required permits for emission sources. Subpart D (201.152 through 210.165) discusses permit application requirements and the review process. Subpart F (201.207 through 201.210) discusses the procedures for permit renewal, revocation, revision, and appeal. Subpart J (201.282 through 201.283) discusses the requirements for monitoring and testing of any emission source for determining the nature and quantities of specified air contaminant emissions. Subpart K (201.301 through 201.302) discusses recordkeeping and report submittal requirements for any emission source.	Portions are relevant and appropriate.	These are the general rules and guidelines for operating permits for any air emission source.
Part 240	Illinois Mobile Sources Standards. This part addresses the rules and regulations regarding the control of emissions from motor vehicles. Subpart A (240.103 and 240.104) addresses the prohibitions on tampering with the air pollution control equipment and the inspection requirements for the exhaust systems of all motor vehicles. Subpart B (240.121) addresses opacity limits for smoke emissions from motor vehicles.	Portions are relevant and appropriate	This project will utilize internal combustion vehicles that will each have an air pollution control device that is regulated under this part.
Part 305	Monitoring and Reporting. This part describes requirements for monitoring, reporting, and measuring contaminant discharges.	Portions are relevant and appropriate.	This rule establishes the monitoring, reporting, and measuring procedures.

Table B-6
Action-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Part 309	Permits. This part addresses permits that may be required for facilities or activities that discharge into the waters of the state. Subpart A (309.101 through 309.185) contains the requirements for which an NPDES permit is necessary. Subpart B (309.201 through 309.282) contains the requirements for other permits that may be required where an NPDES permit is not.	Portions may be relevant and appropriate.	A permit for stormwater discharge from the project site may be required due to the potential of contaminants being present in the excavated material that could be transported offsite during a storm event.
Part 700	Illinois Hazardous Waste Management (HWM) Regulations. Outline of Waste Disposal Regulations. This part sets forth rules that determine which provisions of Parts 700 through 749 are applicable to various persons and facilities. Subchapter A (700.101 through 700.109) contains general provisions for this part. Subchapter B (700.201 through 700.265) contains definitions applicable only to this part. Subchapter C (700.301 through 700.404) contains rules that apply to generators of hazardous waste. Subchapter D (700.401 through 700.404) contains rules that apply to transporters of hazardous waste. Subchapter E (700.501 through 700.504) contains rules that apply to owners or operators of HWM facilities.	Portions may be relevant and acceptable.	These are general rules that apply to anyone who generates or transports hazardous waste or owns or operates a HWM facility.
Part 702	RCRA and UIC Permit Programs. These permit regulations include provisions for two permit programs: The RCRA permit program under Title V and Title X of the Environmental Protection Act and The UIC permit program under Title III and Title X of the Environmental Protection Act. (Not applicable.)	Portions may be relevant and appropriate.	The UIC rules do not apply; only the RCRA rules may apply.

Table B-6
Action-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Part 702 (cont.)	Subpart A (702.101 through 702.110) contains general provisions and definitions that apply to Parts 702, 703, 704, and 705. Subpart B (702.120 through 702.126) contains permit application requirements for both permit programs. Subpart C (702.140 through 702.164) contains permit conditions for both permit programs. Subpart D (702.181 through 702.187) contains conditions for issued permits for both programs.		
Part 703	RCRA Permit Program. This part requires RCRA permits for HWMs, which may include one or more treatment, storage, or disposal units, pursuant to Section 21(f) of the Environmental Protection Act. Subpart A (703.100 through 703.110) contains general provisions for this part. Subpart B (703.120 through 703.160) contains prohibitions to this part. Subpart C (703.140 through 703.211) contains guidelines for authorization of permits by rule and by interim status. Subpart D (703.180 through 703.211) contains requirements for applications for facilities or activities seeking RCRA permits. Subpart E (703.221 through 703.231) contains guidelines for the issuance of short-term or phased permits. Subpart F (703.240 through 703.271) contains guidelines for permit conditions or denials.	Portions may be relevant and appropriate.	This part will apply only to the storage of hazardous waste by the generators.

Table B-6
Action-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Part 720	HWM System: General. This part provides definitions of terms, general standards, and overview information applicable to Parts 720 through 725 and 728. Subpart A (720.101 through 720.103) addresses general information and guidelines. Subpart B (720.110 through 720.111) contains definitions and references. Subpart C (720.120 through 720.122) contains procedures for petitions for rulemaking, getting approvals for alternative testing methods, and for waste delisting.	Portions may be relevant and appropriate.	These rules apply specifically to owners or operators of HWM systems that either treat, store, or dispose of hazardous waste.
Part 722	Standards Applicable to Generators of Hazardous Waste. This part establishes standards for generators who treat, store, or dispose of hazardous waste onsite. Subpart A (722.110 through 722.112) contains general requirements for generators of hazardous wastes. Subpart B (722.120 through 722.131) discusses manifesting requirements for generators of hazardous waste who transport the hazardous waste for offsite treatment, storage, or disposal.	Portions may be relevant and appropriate.	
Part 724	Standards for Owners or Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. This part establishes minimum standards that define the acceptable management of hazardous waste. Subpart A (724.101 through 724.103) discusses general requirements and who is subject to these regulations. Subpart B (724.110 through 724.118) contains general facility standards. Subpart C (724.130 through 724.137) addresses preparedness and prevention requirements of owners and operators of all HWMs for the potential release of hazardous waste into the environment.	Portions may be relevant and appropriate.	

Table B-6
Action-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Part 724 (cont.)	Subpart D (724.150 through 724.155) addresses contingency plan and emergency requirements. Subpart E (724.170 through 724.177) discusses the manifest system recordkeeping and recording requirements. Subpart F (724.190 through 724.201) addresses required compliance monitoring and corrective action requirements when a release from an HWM unit is detected. Subpart G (724.210 through 724.220) addresses closure and post-closure program requirements. Subpart H (724.240 through 724.251) contains financial requirement for the HWM unit owner or operator. Subpart L (724.350 through 724.359) applies to owners or operators of facilities that store or treat hazardous waste in piles.		
Part 725	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities. This part establishes minimum standards that define the acceptable management of hazardous waste during the period of interim status and until certification of final closure or until post-closure responsibilities are fulfilled. Subpart A (725.101 through 725.104) contains general provisions for this part. Subpart B (725.110 through 725.118) addresses general facility standards. Subpart C (725.130 through 725.137) contains release preparedness and prevention requirements for owners and operators of HWM facilities. Subpart D (725.150 through 725.156) contains contingency plan and emergency procedures requirements.	Portions may be relevant and appropriate.	

Table B-6
Action-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Part 725 (cont.)	Subpart E (725.170 through 725.176) contains the requirements for the manifest system's recordkeeping and reporting. Subpart G (725.210 through 725.220) addresses the closure and post-closure plan requirements. Subpart H (725.240 through 725.277) addresses financial requirements for owners and operators of HWM facilities. Subpart L (725.350 through 725.358) applies to owners and operators that treat or store hazardous waste in piles.		
Part 809	Special Waste Hauling. This part prescribes procedures for issuance of permits to special waste haulers and related activities. Subpart A (809.101 through 809.103) contains general requirements and definitions. Subpart B (809.201 through 809.211) addresses general permit requirements for special waste haulers. Subpart C (809.301 through 809.302) pertains to delivery and acceptance requirements for special waste haulers. Subpart D (809.401 through 809.402) address requirements for vehicle numbers and symbols. Subpart E (809.501) addresses manifest, record, and reporting requirements for special waste haulers. Subpart G (809.701) pertains to emergency contingencies for spills.	Portions may be relevant and appropriate	Depends if the waste is recognized as a special waste and not a hazardous waste.

Table B-6
Action-Specific ARARs from the Illinois Administrative Code, Title 35

Potential ARAR	Requirements	Preliminary Determination	Comments
Act 220	Hazardous Waste Equipment Operators and Laborers Act. This act makes it unlawful for any person to operate or assist in the operation of a crane or hoist driven by any power when used in lowering of hoisting personnel or materials involving the disposal, cleanup, or handling of hazardous waste at a facility without first obtaining an operator's license from the agency.	Portions may be relevant and appropriate.	This project will require licensed hazardous waste equipment operators and laborers.

Appendix C

Direct Capital Cost Estimates for the Kerr-McGee Residential Areas Site and Portions of the Kress Creek Site

Appendix C

Direct Capital Cost Estimates for the Kerr-McGee Residential Areas Site and Portions of the Kress Creek Site

1. Remediation crews of 15 people will be used throughout the remediation process.

2. Volumes of material for removal were supplied by the Environmental Protection Agency (EPA). (See Table 4-2 for a discussion of the range of volumes used and their rationale.)

3. It is assumed that each property is 13,000 ft^2 in area.

4. No shoring will be required for normal remediation work because the average depth to be excavated is 2 ft.

5. No cost reduction for using multiple crews for remediation work is assumed.

6. Excavation costs were developed based on a typical crew and productivities for work in confined and open areas.

7. Level-of-protection costs are based on price sheets from O.H. Materials.

8. The removal implementation contractor will be a local firm with a staging area convenient to all properties.

9. Ten days will be required to excavate a property. Backfill and restoration time is additional, but is assumed to be within the time needed to remediate other properties.

10. Major additional cost items are costs that will occur to some degree at each site. For this analysis, 10 percent of all sites was assumed to require additional major costs. The actual number cannot be determined without additional investigation data.

CREW & UNIT COST DEVELOPMENT

PROJECT :KERR-McGEE RESIDENTIAL
CREW :EXCAVATION
RESOURCE :VARIOUS
PROJ.NO :SAE65668.FS.10
BY :CULPEPPER / GNV
FILE :JMC.190/EXC

CREW DEVELOPMENT

CREW DESCRIPTION	NO.	$/HR.	TOTAL $/HR.	EQUIPMENT DESCRIPTION	NO.	$/HR. (W/OPERS)	TOTAL $/HR
1. FOREMAN	1	$26.00	$26.00	1. CAT 225 BACKHOE (CAT 225D - 1.25 CY)	1.0	$62.59	$62.59
2. EQUIPMENT OPERATORS	2	$30.20	$60.40	2. 2 CY LOADER (CASE W20C)	1.0	$23.11	$23.11
3. EQUIP. OILER	1	$22.15	$22.15	3. HOPPER EQUIP. (ALLOWANCE)	1.0	$15.00	$15.00
4. HOPPER OPERATORS	2	$24.39	$48.78	4. ROLLER TRACK (REF. POWERED CONVEYOR)	1.0	$10.28	$10.28
5. LABORERS	4	$22.39	$89.56	5. SMALL TOOLS (ALLOWANCE)	1.0	$5.00	$5.00
6.				6.			
7.							
8.							
9.							
##							
A TOTAL CREW SIZE	10	(HRS/MHR)					
B SUBTOTAL LABOR $			$246.89				
C % INDIRECTS	55.00%		$135.79				
D SUBTOTAL LABOR $			$382.68	A SUBTOTAL EQUIP. $			$115.98
E % LABOR PROFIT				B % EQUIP. PROFIT			
F LABOR $/CREW-HOUR			$382.68	C EQUIP. $/CREW-HOUR			$115.98
G LABOR $/MANHOUR			$38.27	D EQUIP. $/MANHOUR			$11.60
H TOTAL LABOR & EQUIPMENT $/CREWHOUR =			$498.66	E TOTAL LABOR & EQUIPMENT $/MANHR =			$49.87

UNIT COST DEVELOPMENT

WORK ITEM	PRODUCT. UN/HOUR	UNIT	MATERIAL UNIT$	LABOR MHR/UNIT	LABOR UNIT$	EQUIP. UNIT$	TOTAL UNIT$
1. EXCAVATE & LOAD TO HOPPER (50 CY/DY) USE IN CONFINED AREA	6.25	CY/HR		1.60	$61.23	$18.56	$80.00
2. EXCAVATE & LOAD TO HOPPER (100 CY/DY) USE IN OPEN AREA	12.5	CY/HR		0.80	$30.61	$9.28	$40.00
3. EXCAVATE & LOAD TO HOPPER (150 CY/DAY)	18.75	CY/HR		0.53	$20.41	$6.19	$27.00
4. EXCAVATE & LOAD TO HOPPER (200 CY/DAY)	25	CY/HR		0.40	$15.31	$4.64	$20.00
5. EXCAVATE & LOAD TO HOPPER (250 CY/DAY)	31.25	CY/HR		0.32	$12.25	$3.71	$16.00

KERR-McGEE RESIDENTIAL AREAS
WEST CHICAGO, ILL.

(file name: KMASS.xls)BASIS for ADDITIONAL MAJOR COST FACTORS

A	B	C	D	E	F	G	H	I	J	K
SCENARIO	VOLUME REMOVED	NO. of PROPERTIES AFFECTED	TEMP. RELO.	REPLACE MECH. SYSTEMS	BASEMENT REMOVE / REPLACE	MOVE HOUSE	GARAGE REMOVE / REPLACE	VOLUME INVOLVING HAND LABOR	DEEP EXCAVATION REQUIRING SHORING	RADON REDUCTION
			(% of "C")	(% of "C")	(% of "C")	(% of "C")	(% of "C")	(% of "B")	(% of "C")	(% of "C")
			10%	10%	10%	10%	10%	10%	10%	10%
1.	15,000	50	5	5	5	5	5	1500	5	5
2.	30,000	100	10	10	10	10	10	3000	10	10
3.	60,000	200	20	20	20	20	20	6000	20	20
4.	120,000	400	40	40	40	40	40	12000	40	40

ASSUMPTIONS:

1. FAMILY RELOCATIONS INCLUDE 3 PEOPLE / FAMILY. RELOCATION IS 60 DAYS.
2. BASEMENT REPLACEMENT WILL BE BASEMENT SLAB ONLY.
3. GARAGES WILL BE DETACHED UNITS THAT DO NOT AFFECT THE HOUSE STRUCTURE.
4. DEEP EXCAVATION REQUIRING SHORING IS FOR A 10' DEEP x 5' WIDE x 40' LONG EXCAVATION REQUIRING 900 SF OF SHEETING.
5. THE ABOVE ITEMS WILL OCCUR AT THE SAME TIME AS THE BASIC REMEDIATION EFFORT. NO ADDITIONAL HEALTH & SAFETY COSTS WILL BE REQUIRED.

SENSITIVITY:

THE BASIC COSTS HAVE BEEN CALCULATED BASED ON A SCOPE OF WORK THAT IS ASSUMED WILL TAKE PLACE ON EACH PROPERTY. BECAUSE IT CANNOT BE DETERMINED WITH REASONABLE ACCURACY THAT THE SCOPE AS ASSUMED WILL ACTUALLY BE THE COMPLETE SCOPE OF WORK AT EACH PROPERTY, ADDITIONAL MAJOR COST ITEMS THAT MAY OCCUR HAVE ALSO BEEN CALCULATED. IT SHOULD BE ASSUMED THAT A PORTION OF, ALL OF, OR MORE THAN THE SCOPE OF WORK FOR THESE ADDITIONAL ITEMS WILL BE NEEDED TO COMPLETE THE REMEDIATION. THESE FACTORS SHOULD BE CONSIDERED WHEN USING THESE ESTIMATES FOR BUDGET PLANNING.

7/14/94 9:29 PM

ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 1 -

15,000 C.Y.	50 SITES

FILE NAME: JMC.190/KM1

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	EXCAVATION & DISPOSAL COSTS													
1.	EXCAVATION IN OPEN AREAS (90% OF IN-PLACE VOLUME)	10800	CY				$31.00	$334,800	$9.00	$97,200			$432,000	EXCAVATION UNIT COST DEVELOPMENT
2.	EXCAVATION IN CONFINED AREAS (10% OF IN-PLACE VOLUME)	1200	CY				$61.00	$73,200	$19.00	$22,800			$96,000	EXCAVATION UNIT COST DEVELOPMENT
3.	LOAD INTO HOPPERS FROM OPEN AREAS	13,500	CY				$4.65	$62,775	$1.35	$18,225			$81,000	15% OF EXCAVATION COST - M022-250-9024 - 25% SWELL FACTOR
4.	LOAD INTO HOPPERS FROM CONFINED AREAS	1500	CY				$9.15	$13,725	$2.85	$4,275			$18,000	15% OF EXCAVATION COST - M022-250-9024 - 25% SWELL FACTOR
5.	CONTAIN WASTE IN POLYPROYPLENE BAGS & LOAD ON TRUCK	15,000	CY	$13.75	$206,250	.17	$38.27	$95,675	$1.97	$29,580			$331,505	ASSUME 10 MINUTES TO LOAD BAGS
6.	HAUL BAGS TO RAIL SITE	15,000	C.Y.				$0.82	$12,300	$2.58	$38,700			$51,000	M 22-266-1100, M=10.0%, L=10.0%, E=10.0% - 4 MILE ROUND TRIP W/ 16.5 CY DUMP TRUCK
7.	RAIL TRANSPORTATION TO DISPOSAL SITE	25,500	TON								$65.00	$1,657,500	$1,657,500	QUOTE FROM RAILROAD
8.	WASTE CHARACTERIZATION SAMPLING	12	EA								$3,000.00	$36,000	$36,000	3 EVENTS @ 4 SAMPLES / EVENT
9.	DISPOSAL AT ENVIROCARE	15,000	CY								$650.00	$9,750,000	$9,750,000	ENVIROCARE QUOTE FOR MATERIAL LESS THAN 20,000 CY
10.	PROPERTY RESTORATION (13,000 SF / PROPERTY)	162,500	SF								$5.00	$812,500	$812,500	REPLACE ALL DISTURBED SURFACE AREAS & SLABS, WALLS, DECKS, ETC.
11.	VERIFICATION SAMPLING COSTS	200	EA								$350.00	$70,000	$70,000	ASSUME 4 SAMPLES/SITE
12.	HEALTH & SAFETY COSTS	1	LPSM								$615,200.00	$615,200	$615,200	SEE H&S COST DEVELOPMENT SPREADSHEET
13.	TEMPORARY FAMILY RELOCATION (10% of PROPERTIES)	5	EA								$10,500.00	$52,500	$52,500	60-DAY AVE.@ $175/DAY PER DIEM PER 3-MEMBER FAMILY
14.	BACKFILL SITE W/ CLEAN FILL	15,000	CY	$5.00	$75,000		$1.50	$22,500	$0.50	$7,500			$105,000	IMPORTED FILL DIRT AVAILABLE LOCALLY
A	SUBTOTAL				$281,250			$614,975		$218,280		$12,993,700	$14,108,205	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)			$58,359			$127,607		$45,293		$2,696,193	$2,927,453	
C	MOB / BOND / INSUR.	(% of A)			$14,063			$30,749		$10,914		$649,685	$705,410	
D	CONTINGENCY	(% of A)			$42,188			$92,246		$32,742		$1,949,055	$2,116,231	
E	TOTAL ESTIMATED CONSTRUCTION COST				$395,859			$865,577		$307,229		$18,288,633	$19,857,000	

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GENERAL HEALTH & SAFETY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 1 - | 15,000 CY | 50 SITES
FILE NAME: JMC.190/KM1H&S

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	20.00%	20.00%	20.00%	20.00%

FULLTIME WORKERS ONSITE: 15
PROJECT DURATION (MO's.): 18 (50 SITES @ 10 DAYS EACH)

NO.	DESCRIPTION	QTY	UNIT	MATERIALS UNIT $	MATERIALS AMOUNT	LABOR MH	LABOR RATE	LABOR AMOUNT	CONST. EQUIP. UNIT $	CONST. EQUIP. AMOUNT	INSTL or S/C UNIT $	INSTL or S/C AMOUNT	TOTAL	RESOURCE
	INITIAL HEALTH & SAFETY:													
1.	PREPARE HEALTH & SAFETY PLANS	20	DAYS			8.00	$35.00	$5,600					$5,600	
2.	SITE-SPECIFIC TRAINING	60	MHRS				$35.00	$2,100					$2,100	4 HOURS/WORKER
3.	PRE & POST PROJECT MEDICAL EXAMS	30	EACH								$600.00	$18,000	$18,000	2 EXAMS/WORKER
4.	EMERGENCY EXAMS	4	EACH								$600.00	$2,400	$2,400	
5.	NON-DISPOSABLE PROTECTIVE EQUIPMENT	1	LPSM								$5,000.00	$5,000	$5,000	
6.	DECONTAMINATION STATION	2	EACH								$3,500.00	$7,000	$7,000	2-PORTABLES
7.	ESTABLISH SITE ZONES	50	DAYS			24.00	$35.00	$42,000					$42,000	1-DAY/SITE
8.	SAFETY & COMMUNICATION EQUIPMENT	1	LPSM								$5,000.00	$5,000	$5,000	
	CONTINUED HEALTH & SAFETY:													
1.	HEALTH & SAFETY PERSONNEL	54	MONS				$3,000.00	$162,000					$162,000	3 H&S PEOPLE
2.	HANDWASH, LUNCH, CHANGE ACCOMMODATIONS	18	MONS								$300.00	$5,400	$5,400	
3.	HEAT/COLD STRESS MONITORING	180	DAYS				$100.00	$18,000					$18,000	
4.	SAFETY INSPECTIONS	180	DAYS				$50.00	$9,000					$9,000	
5.	MISC. EQUIPMENT RENTAL	18	MONS						$2,000	$36,000			$36,000	
6.	MISC. CONTRACTUAL DUTIES	18	MONS			40.00	$35.00	$25,200					$25,200	LOGS, REPORTS, MEETINGS, ETC.
7.	LEVEL "D" H&S CLOTHING & EQUIP. COSTS for 13 WORKERS	6500	MDAY								$25.00	$162,500	$162,500	$25/PERSON/DAY x CREW SIZE @ 10 DAYS HAZ WORK/SITE - OH MATERIALS PRICE SHEET
8.	LEVEL "C" H&S CLOTHING & EQUIP. COSTS for 2 WORKERS	1000	MDAY								$110.00	$110,000	$110,000	$110/PERSON/DAY x CREW SIZE @ 10 DAYS HAZ WORK/SITE - OH MATERIALS PRICE SHEET
A	SUBTOTAL							$263,900		$36,000		$315,300	$615,200	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 1 -
FILE NAME: JMC.190/KM1A

ADDITIONAL MAJOR COST ITEMS

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	ADDITIONAL MAJOR COST ITEMS													
1.	TEMPORARY RELOCATIONS	5	EA								$10,500.00	$52,500	$52,500	60-DAY AVE.@ $175/DAY PER DIEM PER 3-MEMBER FAMILY
2.	REPLACE HOME MECHANICAL SYSTEMS	5	EA											
	- DEMOLISH EXISTING SYSTEM	5	EA			8.00	$250.00	$10,000					$10,000	1-DAY DEMOLITION CREW @ $250/CREW-HOUR
	- INSTALL NEW UNIT	5	EA	$3,400.00	$17,000		$2,800.00	$14,000					$31,000	M 155-115-2180 - LABOR x 2
	- INSTALL NEW DUCT WORK	5	EA	$1,000.00	$5,000		$1,000.00	$5,000					$10,000	ALLOWANCE
3.	BASEMENT REMOVE / REPLACE	5	EA											
	- DEMOLISH BASEMENT FLOOR	5	EA			16.00	$250.00	$20,000					$20,000	2-DAYS DEMOLITION CREW @ $250/CREW-HOUR
	- REPLACE FLOOR (40'x 40' x6")	148	CY								$200.00	$29,630	$29,630	HIGHER UNIT COST DUE TO RESTRICTED AREA
	- MISC. BASEMENT IMPROVEMENTS	5	EA								$2,000.00	$10,000	$10,000	ALLOWANCE
4.	MOVE HOUSE - (INCLUDES NEW BASEMENT, PATCHING & HOOKUP. ASSUMES HOLDING HOUSE AT REMOTE SITE DURING REMEDIATION - average 1500 sf ground area of house)	5	EA								$64,350.00	$321,750	$321,750	M 021-204-0300 x 2
5.	GARAGE REMOVE / REPLACE	5	EA											
	- DEMOLISH EXISTING GARAGE	5	EA			16.00	$250.00	$20,000					$20,000	2-DAYS DEMOLITION CREW @ $250/CREW-HOUR
	- CONCTRUCT NEW GARAGE (ASSUME 22'x 22')	2420	SF								$15.00	$36,300	$36,300	M 131-204-0400 & 0450
6.	RADON REDUCTION SYSTEM	5	EA.								$3,000.00	$15,000	$15,000	ASSUME POSITIVE PRESSURE SYSTEM
7.	ADDITIONAL COST OF HAND LABOR FOR EXCAVATION	1500	CY				$49.50	$74,250					$74,250	M 022-250-0500
8.	SHORING (900 SF/SITE)	4500	SF								$15.00	$67,500	$67,500	
A	**SUBTOTAL**				$22,000			$143,250				$532,680	$697,930	
B	**OVERHEAD & PROFIT**	(A*ohd) + ((A + ohd)*p)			$4,565			$29,724				$110,531	$144,820	
C	**MOB / BOND / INSUR.**	(% of A)			$1,100			$7,163				$26,634	$34,896	
D	**CONTINGENCY**	(% of A)			$3,300			$21,488				$79,902	$104,689	
E	**TOTAL ESTIMATED CONSTRUCTION COST**				$30,965			$201,624				$749,747	$982,000	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 1 - CONTINGENT ACTION COST ITEMS
FILE NAME: JMC.190/KM1CA

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	
PROFIT =	5.00%	5.00%	5.00%	
MOB/BOND/INS. =	5.00%	5.00%	5.00%	
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	CONTINGENT ACTION COST ITEMS													
1.	HAUL TO RAIL SIDING AN ADDITIONAL 10 MILES FROM SITE	15000	C.Y.				$1.81	$27,150	$5.67	$85,050			$112,200	M 22-266-1130, M=10.0%, L=10.0%, E=10.0% (COSTS ARE INCREMENTAL ABOVE BASE COST ASSUMPTION)
A	SUBTOTAL							$27,150		$85,050			$112,200	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)						$5,634		$17,648			$23,282	
C	MOB / BOND / INSUR.	(% of A)						$1,358		$4,253			$5,610	
D	CONTINGENCY	(% of A)						$4,073		$12,758			$16,830	
E	TOTAL ESTIMATED CONSTRUCTION COST							$38,214		$119,708			$158,000	
2.	INTERIM STORAGE AT REF													
	- UNLOAD BAGS TO STOCKPILE	7500	C.Y.				$0.17	$1,275	$1.97	$14,775			$16,050	ASSUME ONE-HALF TOTAL VOLUME TO BE STOCKPILED
	- LOAD BAGS ONTO FLATBED TRUCK	7500	C.Y.				$0.17	$1,275	$1.97	$14,775			$16,050	
	- STATE TAX	7500	C.Y.								$54.00	$405,000	$405,000	TAX = $2.00/C.F.
A	SUBTOTAL							$2,550		$29,550		$405,000	$437,100	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)						$529		$6,132			$6,661	
C	MOB / BOND / INSUR.	(% of A)						$128		$1,478			$1,605	
D	CONTINGENCY	(% of A)						$383		$4,433		$60,750	$65,565	
E	TOTAL ESTIMATED CONSTRUCTION COST							$3,589		$41,592		$465,750	$511,000	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 2 - | 30,000 C.Y. | 100 SITES
FILE NAME: JMC.190/KM2

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	EXCAVATION & DISPOSAL COSTS													
1.	EXCAVATION IN OPEN AREAS (90% OF IN-PLACE VOLUME)	21600	CY				$31.00	$669,600	$9.00	$194,400			$864,000	EXCAVATION UNIT COST DEVELOPMENT
2.	EXCAVATION IN CONFINED AREAS (10% OF IN-PLACE VOLUME)	2400	CY				$61.00	$146,400	$19.00	$45,600			$192,000	EXCAVATION UNIT COST DEVELOPMENT
3.	LOAD INTO HOPPERS FROM OPEN AREAS	27,000	CY				$4.65	$125,550	$1.35	$36,450			$162,000	15% OF EXCAVATION COST - M022-250-9024 - 25% SWELL FACTOR
4.	LOAD INTO HOPPERS FROM CONFINED AREAS	3000	CY				$9.15	$27,450	$2.85	$8,550			$36,000	15% OF EXCAVATION COST - M022-250-9024 - 25% SWELL FACTOR
5.	CONTAIN WASTE IN POLYPROYPLENE BAGS & LOAD ON TRUCK	30,000	CY	$13.75	$412,500	.17	$38.27	$191,350	$1.97	$59,160			$663,010	ASSUME 10 MINUTES TO LOAD BAGS
6.	HAUL BAGS TO RAIL SITE	30,000	C.Y.				$0.82	$24,600	$2.58	$77,400			$102,000	M 22-266-1100, M=10.0%, L=10.0%, E=10.0% - 4 MILE ROUND TRIP W/ 16.5 CY DUMP TRUCK
7.	RAIL TRANSPORTATION TO DISPOSAL SITE	51,000	TON								$65.00	$3,315,000	$3,315,000	QUOTE FROM RAILROAD
8.	WASTE CHARACTERIZATION SAMPLING	12	EA								$3,000.00	$36,000	$36,000	3 EVENTS @ 4 SAMPLES / EVENT
9.	DISPOSAL AT ENVIROCARE TO 20,000 CY	20,000	CY								$650.00	$13,000,000	$13,000,000	ENVIROCARE QUOTE FOR MATERIAL LESS THAN 20,000 CY
9A.	DISPOSAL AT ENVIROCARE GREATER THAN 20,000 CY	10,000	CY								$275.00	$2,750,000	$2,750,000	ENVIROCARE QUOTE FOR MATERIAL LESS THAN 20,000 CY
10.	PROPERTY RESTORATION (13,000 SF / PROPERTY)	325,000	SF								$5.00	$1,625,000	$1,625,000	REPLACE ALL DISTURBED SURFACE AREAS & SLABS, WALLS, DECKS, ETC.
11.	VERIFICATION SAMPLING COSTS	400	EA								$350.00	$140,000	$140,000	ASSUME 4 SAMPLES/SITE
12.	HEALTH & SAFETY COSTS	1	LPSM								$1,161,900	$1,161,900	$1,161,900	SEE H&S COST DEVELOPMENT SPREADSHEET
13.	TEMPORARY FAMILY RELOCATION (10% of PROPERTIES)	10	EA								$10,500.00	$105,000	$105,000	60-DAY AVE.@ $175/DAY PER DIEM PER 3-MEMBER FAMILY
14.	BACKFILL SITE W/ CLEAN FILL	30,000	CY	$5.00	$150,000		$1.50	$45,000	$0.50	$15,000			$210,000	IMPORTED FILL DIRT AVAILABLE LOCALLY
A	**SUBTOTAL**				$562,500			$1,229,950		$436,560		$22,132,900	$24,361,910	
B	**OVERHEAD & PROFIT**	(A*ohd)+((A+ohd)*p)			$116,719			$255,215		$90,586		$4,592,577	$5,055,096	
C	**MOB / BOND / INSUR.**	(% of A)			$28,125			$61,498		$21,828		$1,106,645	$1,218,096	
D	**CONTINGENCY**	(% of A)			$84,375			$184,493		$65,484		$3,319,935	$3,654,287	
E	**TOTAL ESTIMATED CONSTRUCTION COST**				$791,719			$1,731,155		$614,458		$31,152,057	$34,289,000	

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GENERAL HEALTH & SAFETY

PROJECT : KERR-McGEE REISDENTIAL AREAS

FACILITY : SCENARIO NO. 2 - | 30,000 CY | 100 SITES

FILE NAME: JMC.190/KM2H&S

ESTIMATOR: CULPEPPER/GNV

PROJ. MANAGER: DAN SLOAN/ORO

PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	20.00%	20.00%	20.00%	20.00%

FULLTIME WORKERS ONSITE: 15

PROJECT DURATION (MO's.): 34 (100 SITES @ 10 DAYS EACH)

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	INITIAL HEALTH & SAFETY:													
1.	PREPARE HEALTH & SAFETY PLANS	20	DAYS			8.00	$35.00	$5,600					$5,600	
2.	SITE-SPECIFIC TRAINING	60	MHRS				$35.00	$2,100					$2,100	4 HOURS/WORKER
3.	PRE & POST PROJECT MEDICAL EXAMS	30	EACH								$600.00	$18,000	$18,000	2 EXAMS/WORKER
4.	EMERGENCY EXAMS	4	EACH								$600.00	$2,400	$2,400	
5.	NON-DISPOSABLE PROTECTIVE EQUIPMENT	1	LPSM								$10,000.00	$10,000	$10,000	
6.	DECONTAMINATION STATION	2	EACH								$3,500.00	$7,000	$7,000	2-PORTABLES
7.	ESTABLISH SITE ZONES	100	DAYS			24.00	$35.00	$84,000					$84,000	1-DAY/SITE
8.	SAFETY & COMMUNICATION EQUIPMENT	1	LPSM								$5,000.00	$5,000	$5,000	
	CONTINUED HEALTH & SAFETY:													
1.	HEALTH & SAFETY PERSONNEL	102	MONS				$3,000.00	$306,000					$306,000	3 H&S PEOPLE
2.	HANDWASH, LUNCH, CHANGE ACCOMMODATIONS	34	MONS								$300.00	$10,200	$10,200	
3.	HEAT/COLD STRESS MONITORING	340	DAYS				$100.00	$34,000					$34,000	
4.	SAFETY INSPECTIONS	340	DAYS				$50.00	$17,000					$17,000	
5.	MISC. EQUIPMENT RENTAL	34	MONS						$2,000	$68,000			$68,000	
6.	MISC. CONTRACTUAL DUTIES	34	MONS			40.00	$35.00	$47,600					$47,600	LOGS, REPORTS, MEETINGS, ETC.
7.	LEVEL "D" H&S CLOTHING & EQUIP. COSTS for 13 WORKERS	13000	MDAY								$25.00	$325,000	$325,000	$25/PERSON/DAY x CREW SIZE @ 10 DAYS HAZ WORK/SITE - OH MATERIALS PRICE SHEET
8.	LEVEL "C" H&S CLOTHING & EQUIP. COSTS for 2 WORKERS	2000	MDAY								$110.00	$220,000	$220,000	$110/PERSON/DAY x CREW SIZE @ 10 DAYS HAZ WORK/SITE - OH MATERIALS PRICE SHEET
A	SUBTOTAL							$496,300		$68,000		$597,600	$1,161,900	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 2 -
FILE NAME: JMC.190/KM2A
MARK-UPS:

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

ADDITIONAL MAJOR COST ITEMS

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	ADDITIONAL MAJOR COST ITEMS													
1.	TEMPORARY RELOCATIONS	10	EA								$10,500.00	$105,000	$105,000	60-DAY AVE.@ $175/DAY PER DIEM PER 3-MEMBER FAMILY
2.	REPLACE HOME MECHANICAL SYSTEMS	10	EA											
	- DEMOLISH EXISTING SYSTEM	10	EA			8.00	$250.00	$20,000					$20,000	1-DAY DEMOLITION CREW @ $250/CREW-HOUR
	- INSTALL NEW UNIT	10	EA	$3,400.00	$34,000		$2,800.00	$28,000					$62,000	M 155-115-2180 - LABOR x 2
	- INSTALL NEW DUCT WORK	10	EA	$1,000.00	$10,000		$1,000.00	$10,000					$20,000	ALLOWANCE
3.	BASEMENT REMOVE / REPLACE	10	EA											
	- DEMOLISH BASEMENT FLOOR	10	EA			16.00	$250.00	$40,000					$40,000	2-DAYS DEMOLITION CREW @ $250/CREW-HOUR
	- REPLACE FLOOR (40'x 40' x6")	296	CY								$200.00	$59,259	$59,259	HIGHER UNIT COST DUE TO RESTRICTED AREA
	- MISC. BASEMENT IMPROVEMENTS	10	EA								$2,000.00	$20,000	$20,000	ALLOWANCE
4.	MOVE HOUSE - (INCLUDES NEW BASEMENT, PATCHING & HOOKUP. ASSUMES HOLDING HOUSE AT REMOTE SITE DURING REMEDIATION - average 1500 sf ground area of house)	10	EA								$64,350.00	$643,500	$643,500	M 021-204-0300 x 2
5.	GARAGE REMOVE / REPLACE	10	EA											
	- DEMOLISH EXISTING GARAGE	10	EA			16.00	$250.00	$40,000					$40,000	2-DAYS DEMOLITION CREW @ $250/CREW-HOUR
	- CONCTRUCT NEW GARAGE (ASSUME 22'x 22')	4840	SF								$15.00	$72,600	$72,600	M 131-204-0400 & 0450
6.	RADON REDUCTION SYSTEM	10	EA.								$3,000.00	$30,000	$30,000	ASSUME POSITIVE PRESSURE SYSTEM
7.	ADDITIONAL COST OF HAND LABOR FOR EXCAVATION	3000	CY				$49.50	$148,500					$148,500	M 022-250-0500
8.	SHORING (900 SF/SITE)	9000	SF								$15.00	$135,000	$135,000	
A	**SUBTOTAL**				$44,000			$286,500				$1,065,359	$1,395,859	
B	**OVERHEAD & PROFIT**	(A*ohd)+((A+ohd)*p)			$9,130			$59,449				$221,062	$289,641	
C	**MOB / BOND / INSUR.**	(% of A)			$2,200			$14,325				$53,268	$69,793	
D	**CONTINGENCY**	(% of A)			$6,600			$42,975				$159,804	$209,379	
E	**TOTAL ESTIMATED CONSTRUCTION COST**				$61,930			$403,249				$1,499,493	$1,965,000	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 2 - CONTINGENT ACTION COST ITEMS
FILE NAME: JMC.190/KM2CA

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	
PROFIT =	5.00%	5.00%	5.00%	
MOB/BOND/INS. =	5.00%	5.00%	5.00%	
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS UNIT $	MATERIALS AMOUNT	LABOR MH	LABOR RATE	LABOR AMOUNT	CONST. EQUIP. UNIT $	CONST. EQUIP. AMOUNT	INSTL or S/C UNIT $	INSTL or S/C AMOUNT	TOTAL	RESOURCE
	CONTINGENT ACTION COST ITEMS													
1.	HAUL TO RAIL SIDING AN ADDITIONAL 10 MILES FROM SITE	30000	C.Y.				$1.81	$54,300	$5.67	$170,100			$224,400	M 22-266-1130, M=10.0%, L=10.0%, E=10.0% (COSTS ARE INCREMENTAL ABOVE BASE COST ASSUMPTION)
A	SUBTOTAL							$54,300		$170,100			$224,400	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)						$11,267		$35,296			$46,563	
C	MOB / BOND / INSUR.	(% of A)						$2,715		$8,505			$11,220	
D	CONTINGENCY	(% of A)						$8,145		$25,515			$33,660	
E	TOTAL ESTIMATED CONSTRUCTION COST							$76,427		$239,416			$316,000	
2.	INTERIM STORAGE AT REF													
	- UNLOAD BAGS TO STOCKPILE	15000	C.Y.				$0.17	$2,550	$1.97	$29,550			$32,100	ASSUME ONE-HALF TOTAL VOLUME TO BE STOCKPILED
	- LOAD BAGS ONTO FLATBED TRUCK	15000	C.Y.				$0.17	$2,550	$1.97	$29,550			$32,100	
	- STATE TAX	15000	C.Y.								$54.00	$810,000	$810,000	TAX = $2.00/C.F.
A	SUBTOTAL							$5,100		$59,100		$810,000	$874,200	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)						$1,058		$12,263			$13,322	
C	MOB / BOND / INSUR.	(% of A)						$255		$2,955			$3,210	
D	CONTINGENCY	(% of A)						$765		$8,865		$121,500	$131,130	
E	TOTAL ESTIMATED CONSTRUCTION COST							$7,178		$83,183		$931,500	$1,022,000	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 3 - | 60,000 C.Y. | 200 SITES
FILE NAME: JMC.190/KM3

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	EXCAVATION & DISPOSAL COSTS:													
1.	EXCAVATION IN OPEN AREAS (90% OF IN-PLACE VOLUME)	43200	CY				$31.00	$1,339,200	$9.00	$388,800			$1,728,000	EXCAVATION UNIT COST DEVELOPMENT
2.	EXCAVATION IN CONFINED AREAS (10% OF IN-PLACE VOLUME)	4800	CY				$61.00	$292,800	$19.00	$91,200			$384,000	EXCAVATION UNIT COST DEVELOPMENT
3.	LOAD INTO HOPPERS FROM OPEN AREAS	54,000	CY				$4.65	$251,100	$1.35	$72,900			$324,000	15% OF EXCAVATION COST - M022-250-9024 - 25% SWELL FACTOR
4.	LOAD INTO HOPPERS FROM CONFINED AREAS	6000	CY				$9.15	$54,900	$2.85	$17,100			$72,000	15% OF EXCAVATION COST - M022-250-9024 - 25% SWELL FACTOR
5.	CONTAIN WASTE IN POLYPROYPLENE BAGS & LOAD ON TRUCK	60,000	CY	$13.75	$825,000	.17	$38.27	$382,700	$1.97	$118,320			$1,326,020	ASSUME 10 MINUTES TO LOAD BAGS
6.	HAUL BAGS TO RAIL SITE	60,000	C.Y.				$0.82	$49,200	$2.58	$154,800			$204,000	M 22-266-1100, M=10.0%, L=10.0%, E=10.0% - 4 MILE ROUND TRIP W/ 16.5 CY DUMP TRUCK
7.	RAIL TRANSPORTATION TO DISPOSAL SITE	102,000	TON								$65.00	$6,630,000	$6,630,000	QUOTE FROM RAILROAD
8.	WASTE CHARACTERIZATION SAMPLING	12	EA								$3,000.00	$36,000	$36,000	3 EVENTS @ 4 SAMPLES / EVENT
9.	DISPOSAL AT ENVIROCARE TO 20,000 CY	20,000	CY								$650.00	$13,000,000	$13,000,000	ENVIROCARE QUOTE FOR MATERIAL LESS THAN 20,000 CY
9A.	DISPOSAL AT ENVIROCARE GREATER THAN 20,000 CY	40,000	CY								$275.00	$11,000,000	$11,000,000	ENVIROCARE QUOTE FOR MATERIAL LESS THAN 20,000 CY
10.	PROPERTY RESTORATION (13,000 SF / PROPERTY)	650,000	SF								$5.00	$3,250,000	$3,250,000	REPLACE ALL DISTURBED SURFACE AREAS & SLABS, WALLS, DECKS, ETC.
11.	VERIFICATION SAMPLING COSTS	800	EA								$350.00	$280,000	$280,000	ASSUME 4 SAMPLES/SITE
12.	HEALTH & SAFETY COSTS	1	LPSM								$2,264,500	$2,264,500	$2,264,500	SEE H&S COST DEVELOPMENT SPREADSHEET
13.	TEMPORARY FAMILY RELOCATION (10% of PROPERTIES)	20	EA								$10,500.00	$210,000	$210,000	60-DAY AVE.@ $175/DAY PER DIEM PER 3-MEMBER FAMILY
14.	BACKFILL SITE W/ CLEAN FILL	60,000	CY	$5.00	$300,000		$1.50	$90,000	$0.50	$30,000			$420,000	IMPORTED FILL DIRT AVAILABLE LOCALLY
A	**SUBTOTAL**				$1,125,000			$2,459,900		$873,120		$36,670,500	$41,128,520	
B	**OVERHEAD & PROFIT**	(A*ohd) + ((A + ohd)*p)			$233,438			$510,429		$181,172		$7,609,129	$8,534,168	
C	**MOB / BOND / INSUR.**	(% of A)			$56,250			$122,995		$43,656		$1,833,525	$2,056,426	
D	**CONTINGENCY**	(% of A)			$168,750			$368,985		$130,968		$5,500,575	$6,169,278	
E	**TOTAL ESTIMATED CONSTRUCTION COST**				$1,583,438			$3,462,309		$1,228,916		$51,613,729	$57,888,000	

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GENERAL HEALTH & SAFETY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 3 -
FILE NAME: JMC.190/KM3H&S
MARK-UPS:

60,000 CY	200 SITES		

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	20.00%	20.00%	20.00%	20.00%

FULLTIME WORKERS ONSITE: 15
PROJECT DURATION (MO's.): 67 (200 SITES @ 10 DAYS EACH)

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

NO.	DESCRIPTION	QTY	UNIT	MATERIALS UNIT $	MATERIALS AMOUNT	LABOR MH	LABOR RATE	LABOR AMOUNT	CONST. EQUIP. UNIT $	CONST. EQUIP. AMOUNT	INSTL or S/C UNIT $	INSTL or S/C AMOUNT	TOTAL	RESOURCE
	INITIAL HEALTH & SAFETY:													
1.	PREPARE HEALTH & SAFETY PLANS	20	DAYS			8.00	$35.00	$5,600					$5,600	
2.	SITE-SPECIFIC TRAINING	60	MHRS				$35.00	$2,100					$2,100	4 HOURS/WORKER
3.	PRE & POST PROJECT MEDICAL EXAMS	30	EACH								$600.00	$18,000	$18,000	2 EXAMS/WORKER
4.	EMERGENCY EXAMS	4	EACH								$600.00	$2,400	$2,400	
5.	NON-DISPOSABLE PROTECTIVE EQUIPMENT	1	LPSM								$15,000.00	$15,000	$15,000	
6.	DECONTAMINATION STATION	2	EACH								$3,500.00	$7,000	$7,000	2-PORTABLES
7.	ESTABLISH SITE ZONES	200	DAYS			24.00	$35.00	$168,000					$168,000	1-DAY/SITE
8.	SAFETY & COMMUNICATION EQUIPMENT	1	LPSM								$5,000.00	$5,000	$5,000	
	CONTINUED HEALTH & SAFETY:													
1.	HEALTH & SAFETY PERSONNEL	201	MONS				$3,000.00	$603,000					$603,000	3 H&S PEOPLE
2.	HANDWASH, LUNCH, CHANGE ACCOMMODATIONS	67	MONS								$300.00	$20,100	$20,100	
3.	HEAT/COLD STRESS MONITORING	670	DAYS				$100.00	$67,000					$67,000	
4.	SAFETY INSPECTIONS	670	DAYS				$50.00	$33,500					$33,500	
5.	MISC. EQUIPMENT RENTAL	67	MONS						$2,000	$134,000			$134,000	
6.	MISC. CONTRACTUAL DUTIES	67	MONS			40.00	$35.00	$93,800					$93,800	LOGS, REPORTS, MEETINGS, ETC.
7.	LEVEL "D" H&S CLOTHING & EQUIP. COSTS for 13 WORKERS	26000	MDAY								$25.00	$650,000	$650,000	$25/PERSON/DAY x CREW SIZE @ 10 DAYS HAZ WORK/SITE - OH MATERIALS PRICE SHEET
8.	LEVEL "C" H&S CLOTHING & EQUIP. COSTS for 2 WORKERS	4000	MDAY								$110.00	$440,000	$440,000	$110/PERSON/DAY x CREW SIZE @ 10 DAYS HAZ WORK/SITE - OH MATERIALS PRICE SHEET
A	SUBTOTAL							$973,000		$134,000		$1,157,500	$2,264,500	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 3 - ADDITIONAL MAJOR COST ITEMS
FILE NAME: JMC.190/KM3A

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	ADDITIONAL MAJOR COST ITEMS													
1.	TEMPORARY RELOCATIONS	20	EA								#########	$210,000	$210,000	60-DAY AVE.@ $175/DAY PER DIEM PER 3-MEMBER FAMILY
2.	REPLACE HOME MECHANICAL SYSTEMS	20	EA											
	- DEMOLISH EXISTING SYSTEM	20	EA			8.00	$250.00	$40,000					$40,000	1-DAY DEMOLITION CREW @ $250/CREW-HOUR
	- INSTALL NEW UNIT	20	EA	$3,400.00	$68,000		########	$56,000					$124,000	M 155-115-2180 - LABOR x 2
	- INSTALL NEW DUCT WORK	20	EA	$1,000.00	$20,000		########	$20,000					$40,000	ALLOWANCE
3.	BASEMENT REMOVE / REPLACE	20	EA											
	- DEMOLISH BASEMENT FLOOR	20	EA			16.00	$250.00	$80,000					$80,000	2-DAYS DEMOLITION CREW @ $250/CREW-HOUR
	- REPLACE FLOOR (40'x 40' x6")	593	CY								$200.00	$118,519	$118,519	HIGHER UNIT COST DUE TO RESTRICTED AREA
	- MISC. BASEMENT IMPROVEMENTS	20	EA								$2,000.00	$40,000	$40,000	ALLOWANCE
4.	MOVE HOUSE - (INCLUDES NEW BASEMENT, PATCHING & HOOKUP. ASSUMES HOLDING HOUSE AT REMOTE SITE DURING REMEDIATION - average 1500 sf ground area of house)	20	EA								#########	$1,287,000	$1,287,000	M 021-204-0300 x 2
5.	GARAGE REMOVE / REPLACE	20	EA											
	- DEMOLISH EXISTING GARAGE	20	EA			16.00	$250.00	$80,000					$80,000	2-DAYS DEMOLITION CREW @ $250/CREW-HOUR
	- CONCTRUCT NEW GARAGE (ASSUME 22'x 22')	9680	SF								$15.00	$145,200	$145,200	M 131-204-0400 & 0450
6.	RADON REDUCTION SYSTEM	20	EA.								$3,000.00	$60,000	$60,000	ASSUME POSITIVE PRESSURE SYSTEM
7.	ADDITIONAL COST OF HAND LABOR FOR EXCAVATION	6000	CY				$49.50	$297,000					$297,000	M 022-250-0500
8.	SHORING (900 SF/SITE)	18000	SF								$15.00	$270,000	$270,000	
A	**SUBTOTAL**				$88,000			$573,000				$2,130,719	$2,791,719	
B	**OVERHEAD & PROFIT**	(A*ohd) + ((A + ohd)*p)			$18,260			$118,898				$442,124	$579,282	
C	**MOB / BOND / INSUR.**	(% of A)			$4,400			$28,650				$106,536	$139,586	
D	**CONTINGENCY**	(% of A)			$13,200			$85,950				$319,608	$418,758	
E	**TOTAL ESTIMATED CONSTRUCTION COST**				$123,860			$806,498				$2,998,986	$3,929,000	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 3 - CONTINGENT ACTION COST ITEMS
FILE NAME: JMC.190/KM3CA

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	
PROFIT =	5.00%	5.00%	5.00%	
MOB/BOND/INS. =	5.00%	5.00%	5.00%	
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	CONTINGENT ACTION COST ITEMS													
1.	HAUL TO RAIL SIDING AN ADDITIONAL 10 MILES FROM SITE	60000	C.Y.				$1.81	$108,600	$5.67	$340,200			$448,800	M 22-266-1130, M=10.0%, L=10.0%, E=10.0% (COSTS ARE INCREMENTAL ABOVE BASE COST ASSUMPTION)
A	SUBTOTAL							$108,600		$340,200			$448,800	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)						$22,535		$70,591			$93,126	
C	MOB / BOND / INSUR.	(% of A)						$5,430		$17,010			$22,440	
D	CONTINGENCY	(% of A)						$16,290		$51,030			$67,320	
E	TOTAL ESTIMATED CONSTRUCTION COST							$152,855		$478,832			$632,000	
2.	INTERIM STORAGE AT REF													
	- UNLOAD BAGS TO STOCKPILE	30000	C.Y.				$0.17	$5,100	$1.97	$59,100			$64,200	ASSUME ONE-HALF TOTAL VOLUME TO BE STOCKPILED
	- LOAD BAGS ONTO FLATBED TRUCK	30000	C.Y.				$0.17	$5,100	$1.97	$59,100			$64,200	
	- STATE TAX	30000	C.Y.								$54.00	$1,620,000	$1,620,000	TAX = $2.00/C.F.
A	SUBTOTAL							$10,200		$118,200		$1,620,000	$1,748,400	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)						$2,117		$24,527			$26,643	
C	MOB / BOND / INSUR.	(% of A)						$510		$5,910			$6,420	
D	CONTINGENCY	(% of A)						$1,530		$17,730		$243,000	$262,260	
E	TOTAL ESTIMATED CONSTRUCTION COST							$14,357		$166,367		$1,863,000	$2,044,000	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 4 -
FILE NAME: JMC.190/KM4
MARK-UPS:

120,000	C.Y.	400	SITES

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS UNIT $	MATERIALS AMOUNT	LABOR MH	LABOR RATE	LABOR AMOUNT	CONST. EQUIP. UNIT $	CONST. EQUIP. AMOUNT	INSTL or S/C UNIT $	INSTL or S/C AMOUNT	TOTAL	RESOURCE
	EXCAVATION & DISPOSAL COSTS:													
1.	EXCAVATION IN OPEN AREAS (90% OF IN-PLACE VOLUME)	86400	CY				$31.00	$2,678,400	$9.00	$777,600			$3,456,000	EXCAVATION UNIT COST DEVELOPMENT
2.	EXCAVATION IN CONFINED AREAS (10% OF IN-PLACE VOLUME)	9600	CY				$61.00	$585,600	$19.00	$182,400			$768,000	EXCAVATION UNIT COST DEVELOPMENT
3.	LOAD INTO HOPPERS FROM OPEN AREAS	108,000	CY				$4.65	$502,200	$1.35	$145,800			$648,000	15% OF EXCAVATION COST - M022-250-9024 - 25% SWELL FACTOR
4.	LOAD INTO HOPPERS FROM CONFINED AREAS	12000	CY				$9.15	$109,800	$2.85	$34,200			$144,000	15% OF EXCAVATION COST - M022-250-9024 - 25% SWELL FACTOR
5.	CONTAIN WASTE IN POLYPROYPLENE BAGS & LOAD ON TRUCK	120,000	CY	$13.75	$1,650,000	.17	$38.27	$765,400	$1.97	$236,640			$2,652,040	ASSUME 10 MINUTES TO LOAD BAGS
6.	HAUL BAGS TO RAIL SITE	120,000	C.Y.				$0.82	$98,400	$2.58	$309,600			$408,000	M 22-266-1100, M=10.0%, L=10.0%, E=10.0% - 4 MILE ROUND TRIP W/ 16.5 CY DUMP TRUCK
7.	RAIL TRANSPORTATION TO DISPOSAL SITE	204,000	TON								$65.00	$13,260,000	$13,260,000	QUOTE FROM RAILROAD
8.	WASTE CHARACTERIZATION SAMPLING	12	EA								$3,000.00	$36,000	$36,000	3 EVENTS @ 4 SAMPLES / EVENT
9.	DISPOSAL AT ENVIROCARE TO 20,000 CY	20,000	CY								$650.00	$13,000,000	$13,000,000	ENVIROCARE QUOTE FOR MATERIAL LESS THAN 20,000 CY
9A.	DISPOSAL AT ENVIROCARE GREATER THAN 20,000 CY	100,000	CY								$275.00	$27,500,000	$27,500,000	ENVIROCARE QUOTE FOR MATERIAL LESS THAN 20,000 CY
10.	PROPERTY RESTORATION (13,000 SF / PROPERTY)	1,300,000	SF								$5.00	$6,500,000	$6,500,000	REPLACE ALL DISTURBED SURFACE AREAS & SLABS, WALLS, DECKS, ETC.
11.	VERIFICATION SAMPLING COSTS	1,600	EA								$350.00	$560,000	$560,000	ASSUME 4 SAMPLES/SITE
12.	HEALTH & SAFETY COSTS	1	LPSM								$4,478,900	$4,478,900	$4,478,900	SEE H&S COST DEVELOPMENT SPREADSHEET
13.	TEMPORARY FAMILY RELOCATION (10% of PROPERTIES)	40	EA								$10,500.00	$420,000	$420,000	60-DAY AVE.@ $175/DAY PER DIEM PER 3-MEMBER FAMILY
14.	BACKFILL SITE W/ CLEAN FILL	120,000	CY	$5.00	$600,000		$1.50	$180,000	$0.50	$60,000			$840,000	IMPORTED FILL DIRT AVAILABLE LOCALLY
A	SUBTOTAL				$2,250,000			$4,919,800		$1,746,240		$65,754,900	$74,670,940	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)			$466,875			$1,020,859		$362,345		$13,644,142	$15,494,220	
C	MOB / BOND / INSUR.	(% of A)			$112,500			$245,990		$87,312		$3,287,745	$3,733,547	
D	CONTINGENCY	(% of A)			$337,500			$737,970		$261,936		$9,863,235	$11,200,641	
E	TOTAL ESTIMATED CONSTRUCTION COST				$3,166,875			$6,924,619		$2,457,833		$92,550,022	$105,099,000	

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GENERAL HEALTH & SAFETY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 4 - | 120,000 CY | 400 SITES
FILE NAME: JMC.190/KM4H&S

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	20.00%	20.00%	20.00%	20.00%

FULLTIME WORKERS ONSITE	15	
PROJECT DURATION (MO's.)	134	(400 SITES @ 10 DAYS EACH)

NO.	DESCRIPTION	QTY	UNIT	MATERIALS UNIT $	MATERIALS AMOUNT	LABOR MH	LABOR RATE	LABOR AMOUNT	CONST. EQUIP. UNIT $	CONST. EQUIP. AMOUNT	INSTL or S/C UNIT $	INSTL or S/C AMOUNT	TOTAL	RESOURCE
	INITIAL HEALTH & SAFETY:													
1.	PREPARE HEALTH & SAFETY PLANS	20	DAYS			8.00	$35.00	$5,600					$5,600	
2.	SITE-SPECIFIC TRAINING	60	MHRS				$35.00	$2,100					$2,100	4 HOURS/WORKER
3.	PRE & POST PROJECT MEDICAL EXAMS	30	EACH								$600.00	$18,000	$18,000	2 EXAMS/WORKER
4.	EMERGENCY EXAMS	4	EACH								$600.00	$2,400	$2,400	
5.	NON-DISPOSABLE PROTECTIVE EQUIPMENT	1	LPSM								$20,000.00	$20,000	$20,000	
6.	DECONTAMINATION STATION	2	EACH								$3,500.00	$7,000	$7,000	2-PORTABLES
7.	ESTABLISH SITE ZONES	400	DAYS			24.00	$35.00	$336,000					$336,000	1-DAY/SITE
8.	SAFETY & COMMUNICATION EQUIPMENT	1	LPSM								$5,000.00	$5,000	$5,000	
	CONTINUED HEALTH & SAFETY:													
1.	HEALTH & SAFETY PERSONNEL	402	MONS				$3,000.00	$1,206,000					$1,206,000	3 H&S PEOPLE
2.	HANDWASH, LUNCH, CHANGE ACCOMMODATIONS	134	MONS								$300.00	$40,200	$40,200	
3.	HEAT/COLD STRESS MONITORING	1340	DAYS				$100.00	$134,000					$134,000	
4.	SAFETY INSPECTIONS	1340	DAYS				$50.00	$67,000					$67,000	
5.	MISC. EQUIPMENT RENTAL	134	MONS						$2,000	$268,000			$268,000	
6.	MISC. CONTRACTUAL DUTIES	134	MONS			40.00	$35.00	$187,600					$187,600	LOGS, REPORTS, MEETINGS, ETC.
7.	LEVEL "D" H&S CLOTHING & EQUIP. COSTS for 13 WORKERS	52000	MDAY								$25.00	$1,300,000	$1,300,000	$25/PERSON/DAY x CREW SIZE @ 10 DAYS HAZ WORK/SITE - OH MATERIALS PRICE SHEET
8.	LEVEL "C" H&S CLOTHING & EQUIP. COSTS for 2 WORKERS	8000	MDAY								$110.00	$880,000	$880,000	$110/PERSON/DAY x CREW SIZE @ 10 DAYS HAZ WORK/SITE - OH MATERIALS PRICE SHEET
A	SUBTOTAL							$1,938,300		$268,000		$2,272,600	$4,478,900	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 4 -
FILE NAME: JMC.190/KM4A

ADDITIONAL MAJOR COST ITEMS

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
MOB/BOND/INS. =	5.00%	5.00%	5.00%	5.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	ADDITIONAL MAJOR COST ITEMS													
1.	TEMPORARY RELOCATIONS	40	EA								#########	$420,000	**$420,000**	60-DAY AVE.@ $175/DAY PER DIEM PER 3-MEMBER FAMILY
2.	REPLACE HOME MECHANICAL SYSTEMS	40	EA											
	- DEMOLISH EXISTING SYSTEM	40	EA			8.00	$250.00	$80,000					**$80,000**	1-DAY DEMOLITION CREW @ $250/CREW-HOUR
	- INSTALL NEW UNIT	40	EA	$3,400.00	$136,000		#######	$112,000					**$248,000**	M 155-115-2180 - LABOR x 2
	- INSTALL NEW DUCT WORK	40	EA	$1,000.00	$40,000		#######	$40,000					**$80,000**	ALLOWANCE
3.	BASEMENT REMOVE / REPLACE	40	EA											
	- DEMOLISH BASEMENT FLOOR	40	EA			16.00	$250.00	$160,000					**$160,000**	2-DAYS DEMOLITION CREW @ $250/CREW-HOUR
	- REPLACE FLOOR (40'x 40' x6")	1185	CY								$200.00	$237,037	**$237,037**	HIGHER UNIT COST DUE TO RESTRICTED AREA
	- MISC. BASEMENT IMPROVEMENTS	40	EA								$2,000.00	$80,000	**$80,000**	ALLOWANCE
4.	MOVE HOUSE - (INCLUDES NEW BASEMENT, PATCHING & HOOKUP. ASSUMES HOLDING HOUSE AT REMOTE SITE DURING REMEDIATION - average 1500 sf ground area of house)	40	EA								#########	$2,574,000	**$2,574,000**	M 021-204-0300 x 2
5.	GARAGE REMOVE / REPLACE	40	EA											
	- DEMOLISH EXISTING GARAGE	40	EA			16.00	$250.00	$160,000					**$160,000**	2-DAYS DEMOLITION CREW @ $250/CREW-HOUR
	- CONCTRUCT NEW GARAGE (ASSUME 22'x 22')	19360	SF								$15.00	$290,400	**$290,400**	M 131-204-0400 & 0450
6.	RADON REDUCTION SYSTEM	40	EA.								$3,000.00	$120,000	**$120,000**	ASSUME POSITIVE PRESSURE SYSTEM
7.	ADDITIONAL COST OF HAND LABOR FOR EXCAVATION	12000	CY				$49.50	$594,000					**$594,000**	M 022-250-0500
8.	SHORING (900 SF/SITE)	36000	SF								$15.00	$540,000	**$540,000**	
A	**SUBTOTAL**				$176,000			$1,146,000				$4,261,437	**$5,583,437**	
B	**OVERHEAD & PROFIT**	(A*ohd)+((A+ohd)*p)			$36,520			$237,795				$884,248	**$1,158,563**	
C	**MOB / BOND / INSUR.**	(% of A)			$8,800			$57,300				$213,072	**$279,172**	
D	**CONTINGENCY**	(% of A)			$26,400			$171,900				$639,216	**$837,516**	
E	**TOTAL ESTIMATED CONSTRUCTION COST**				**$247,720**			**$1,612,995**				**$5,997,973**	**$7,859,000**	

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ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : SCENARIO NO. 4 - **CONTINGENT ACTION COST ITEMS**
FILE NAME: JMC.190/KM4CA

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	
PROFIT =	5.00%	5.00%	5.00%	
MOB/BOND/INS. =	5.00%	5.00%	5.00%	
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS UNIT $	MATERIALS AMOUNT	LABOR MH	LABOR RATE	LABOR AMOUNT	CONST. EQUIP. UNIT $	CONST. EQUIP. AMOUNT	INSTL or S/C UNIT $	INSTL or S/C AMOUNT	TOTAL	RESOURCE
	CONTINGENT ACTION COST ITEMS													
1.	HAUL TO RAIL SIDING AN ADDITIONAL 10 MILES FROM SITE	120000	C.Y.				$1.81	$217,200	$5.67	$680,400			$897,600	M 22-266-1130, M=10.0%, L=10.0%, E=10.0% (COSTS ARE INCREMENTAL ABOVE BASE COST ASSUMPTION)
A	SUBTOTAL							$217,200		$680,400			$897,600	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)						$45,069		$141,183			$186,252	
C	MOB / BOND / INSUR.	(% of A)						$10,860		$34,020			$44,880	
D	CONTINGENCY	(% of A)						$32,580		$102,060			$134,640	
E	TOTAL ESTIMATED CONSTRUCTION COST							$305,709		$957,663			$1,263,000	
2.	INTERIM STORAGE AT REF													
	- UNLOAD BAGS TO STOCKPILE	60000	C.Y.				$0.17	$10,200	$1.97	$118,200			$128,400	ASSUME ONE-HALF TOTAL VOLUME TO BE STOCKPILED
	- LOAD BAGS ONTO FLATBED TRUCK	60000	C.Y.				$0.17	$10,200	$1.97	$118,200			$128,400	
	- STATE TAX	60000	C.Y.								$54.00	$3,240,000	$3,240,000	TAX = $2.00/C.F.
A	SUBTOTAL							$20,400		$236,400		$3,240,000	$3,496,800	
B	OVERHEAD & PROFIT	(A*ohd)+((A+ohd)*p)						$4,233		$49,053			$53,286	
C	MOB / BOND / INSUR.	(% of A)						$1,020		$11,820			$12,840	
D	CONTINGENCY	(% of A)						$3,060		$35,460		$486,000	$524,520	
E	TOTAL ESTIMATED CONSTRUCTION COST							$28,713		$332,733		$3,726,000	$4,087,000	

7/8/94 9:20 AM

ESTIMATE SUMMARY

PROJECT : KERR-McGEE REISDENTIAL AREAS
FACILITY : RESIDENTIAL FLOOD PROTECTION
FILE NAME: JMC.190/FLOOD

ESTIMATOR: CULPEPPER/GNV
PROJ. MANAGER: DAN SLOAN/ORO
PROJ.NO.: SAE65658.FS.10

MARK-UPS:

	MATL	LABOR	EQUIP.	INSTL or S/C
OVERHEAD =	15.00%	15.00%	15.00%	15.00%
PROFIT =	5.00%	5.00%	5.00%	5.00%
BOND/INS. =	2.00%	2.00%	2.00%	2.00%
CONTINGENCY =	15.00%	15.00%	15.00%	15.00%

NO.	DESCRIPTION	QTY	UNIT	MATERIALS		LABOR			CONST. EQUIP.		INSTL or S/C		TOTAL	RESOURCE
				UNIT $	AMOUNT	MH	RATE	AMOUNT	UNIT $	AMOUNT	UNIT $	AMOUNT		
	ZONE 2 PROTECTION													
1.	MOBILIZATION	1	LS								$20,000.00	$20,000	$20,000	AVERAGE MOB. COST
2.	ACCESS ROAD ALONG SHEET PILE LENGTH	3200	LF								$10.00	$32,000	$32,000	TEMPORARY GRAVEL ROAD
3.	STEEL SHEET PILING, 22PSF, NO WATER, FOR 15' EXCAV, PULL & SALVAGE	51,200	S.F.	$2.09	$107,008		$2.60	$133,120	$3.12	$159,744			$399,872	M 21-614-1300, M = 10.0%, L = 10.0%, E = 10.0%
4.	SITE RESTORATION	3200	LF								$15.00	$48,000	$48,000	ALLOWANCE
5.	12" DIAMETER CHECK VALVES @ 100' O.C.	32	EA								$3,000.00	$96,000	$96,000	PRATT VALVE & CH2M HILL
A	SUBTOTAL				$107,008			$133,120		$159,744		$196,000	$595,872	
B	OVERHEAD & PROFIT	(A*ohd) + ((A + ohd)*p)			$22,204			$27,622		$33,147		$40,670	$123,643	
C	MOB / BOND / INSUR.	(% of A)			$2,140			$2,662		$3,196		$3,920	$11,917	
D	CONTINGENCY	(% of A)			$16,051			$19,968		$23,962		$29,400	$89,381	
E	TOTAL ESTIMATED CONSTRUCTION COST				$147,404			$183,373		$220,047		$269,990	$821,000	
	ZONE 3 PROTECTION													
1.	MOBILIZATION	1	LS								$20,000.00	$20,000	$20,000	AVERAGE MOB. COST
2.	ACCESS ROAD ALONG SHEET PILE LENGTH	2000	LF								$10.00	$20,000	$20,000	TEMPORARY GRAVEL ROAD
3.	STEEL SHEET PILING, 22PSF, NO WATER, FOR 15' EXCAV, PULL & SALVAGE	34,000	S.F.	$2.09	$71,060		$2.60	$88,400	$3.12	$106,080			$265,540	M 21-614-1300, M = 10.0%, L = 10.0%, E = 10.0%
4.	SITE RESTORATION	2000	LF								$15.00	$30,000	$30,000	ALLOWANCE
5.	12" DIAMETER CHECK VALVES @ 100' O.C.	20	EA								$3,000.00	$60,000	$60,000	PRATT VALVE & CH2M HILL
A	SUBTOTAL				$71,060			$88,400		$106,080		$130,000	$395,540	
B	OVERHEAD & PROFIT	(A*ohd) + ((A + ohd)*p)			$14,745			$18,343		$22,012		$26,975	$82,075	
C	MOB / BOND / INSUR.	(% of A)			$1,421			$1,768		$2,122		$2,600	$7,911	
D	CONTINGENCY	(% of A)			$10,659			$13,260		$15,912		$19,500	$59,331	
E	TOTAL ESTIMATED CONSTRUCTION COST				$97,885			$121,771		$146,126		$179,075	$545,000	